THE

MYOLOGY OF THE RAVEN

(*Corvus corax sinuatus*).

A GUIDE TO THE STUDY OF THE MUSCULAR SYSTEM IN BIRDS.

BY

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PREFACE.

THERE has not yet been published, so far as the writer is aware, any work devoted to a complete account of the muscles of any single species of the Class *Aves,*—a work fully and practically illustrated, and one that would prove itself to be of service to those either engaged in the general study of the morphology of vertebrates, or to those special students who may be investigating the myology of birds. At the present time,—when the study of the structure of animals is becoming far more general, as one of the most efficient aids to observation and mental training, than it was so considered a number of years ago,—books of the class which your author has here endeavoured to produce come to be very useful. Birds stand among the most easily procurable subjects for the use of the demonstrator at the laboratory, or for the student to employ in his own researches at home as illustrative of certain parts of his course in biology. And it was to fill this so important a gap, as the lack of a suitable volume devoted to the muscular system of birds, that the writer undertook an exhaustive study of the muscles of the Raven (*Corvus corax*

sinuatus); and the work here placed before the reader, with its eighty and odd figures, is the outcome of those investigations.

With regard to my nomenclature of the muscles I have here described and figured, I have been guided by such brief chapters as are devoted to this subject and which appear in the published scientific memoirs of such excellent authorities as Owen, Carus, A. Milne-Edwards, Huxley, Garrod, Forbes, Selenka, Coues, Fürbringer, and Gadow; but when I have been in doubt, and these authorities failed to assist me, I have endeavoured to bestow upon the muscle a suitable name. The student must bear in mind, too, that many other birds possess muscles which are not to be found in the Raven; in some special cases I have alluded to these. On the other hand, the muscles, even in the representatives of the same species, may vary in certain individuals to some extent. This fact has long been appreciated by anthropotomists.

Gadow's work upon the muscles of birds, which appeared in Bronn's *Thier-Reichs*, is an admirable contribution to the general subject; but it is by no means a work that meets the general want, and possesses the disadvantages of being but meagrely illustrated, and of having appeared in German, in a work of limited circulation. Notwithstanding this, I am quite sure my reader will feel grateful for my having incorporated Gadow's synonymy in footnotes in the present volume, as they cannot fail to be anything but the most useful adjunct to a guide to avian myology.

In arranging and grouping the elements of this

system, it is to be hoped that the writer's plan will be found to be a convenient and helpful one: it was his chief aim throughout, next to accuracy and clearness of description, to make it so.

In choosing the Raven for our subject, it was done in view of the fact that it is a large representative of a very numerous and cosmopolitan family of birds, the *Corvidæ;* so that, in almost any part of the world, a variety of birds become available whose muscular systems can be studied by the aid of the present volume. It is hardly necessary to add that Crows of all descriptions, Jays, Orioles, and a host of others, all fall within this category. It has its advantage, too, for the teacher and the student at the biological laboratory; for the former can use as his subject the larger and more advantageous specimens, as the Ravens or Crows, while the latter can confirm the instructions of the former, at home, upon any of the smaller varieties of the *Corvidæ,* such as the Jays or Rooks.

As his investigations in the myology of vertebrates progress, three lines for improvement, in so far as our knowledge of the muscular system of birds is concerned, will force themselves upon the student. In the first place, we still remain very ignorant of the details of this system in a great many important types of birds; secondly, an ever-pressing demand is evident, to fix the homologies of muscles in the Vertebrata, and consequently to bring so far-reaching a knowledge of this department of research to our assistance as to be enabled to give the same name to the same muscles, accurately, throughout the vertebrate series; finally, a simple,

scientific, and euphonious nomenclature is very much to be desired. As an index of our present status with respect to our knowledge of the muscles of birds, it is hoped that the volume here offered will faithfully represent it, but its writer trusts that in future works he may lend his assistance to the improvement of all the lines above indicated. To this end, he will be thankful for any suggestions that may be useful should the present volume go to another edition, and good criticism of the same will be welcomed from any quarter. Already, the question of neuro-myology, or the nomenclature of muscles based upon their nerve-supply, has made considerable progress in modifying our views in that direction, and although I am convinced that it by no means always furnishes an invariable guide to follow, still its great usefulness is not to be ignored. With no little interest I have read the "Neuro-myology" of Coues and Shute (*New York Medical Record*, July, 1887), and am compelled to admire the masterly manner in which they have instilled new life into an old theme. Unfortunately, the *same muscle* as represented in different types of the vertebrate series, is not always served by the *same nerve*, and this would stand in the way of a general grouping and a universal neuro-myological nomenclature upon any such a basis. To those of my readers who are familiar with German, the best works I can recommend to be consulted in the present connection are the very excellent treatises of Selenka and Gadow in Bronn's *Klassen des Thier-Reichs;* and that superb monument to avian morphology, the *Untersuchungen zur Morphologie und Systematik der*

Vögel of Max Fürbringer. To Professor Gadow I am indebted for a great many titles of works which I have incorporated in the bibliography which is found at the end of this volume; still, I have personally examined the majority of books there enumerated.

English and American literature, as I have already stated, furnishes us with no good handbook to the subject.

Frequently, an author, as he closes his prefatory remarks, finds that he has a host of helpful friends to whom his thanks are due for assistance rendered: it proves to be the exception in the present instance, for all of the material used was collected by myself; all the dissections were made by myself; all the descriptions are in my own handwriting; and the drawings were all drawn directly from the dissections by myself. Still it gives me pleasure to remember here my friend Dr. J. L. Wortman, the biologist of the United States Army Medical Museum, who, several years after this volume was written, carefully passed over with me the musculature of the shoulder-joint in birds, and verified my dissections upon the Raven, comparing them with similar studies he was at the time engaged upon in the *Raptores*. Further it gives me pleasure to express my thanks to Dr. G. Brown Goode, of the United States National Museum, for having upon a number of occasions furnished me with the means of preserving my somewhat extensive material, and that, too, when my labours upon the present volume were being prosecuted in New Mexico, between two and three thousand miles from civilization, the libraries, and the

museums; and that at a time when the operations of a short-sighted and destructive policy which influences our Government in its attitude toward scientific investigators came quite near placing the researches herein tendered to my readers and collaborators in anatomy, beyond the pale of publication.

R. W. S.

TAKOMA, D.C.
August 20, 1889.

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LIST OF ILLUSTRATIONS.

[NOTE:—All the figures illustrating this work were drawn by the author, and with but few exceptions, where they have been copied from the drawings of other anatomists, were made directly from the recent dissections, and in the vast majority of cases the size of life.]

THE

MYOLOGY OF THE RAVEN

(*Corvus corax sinuatus*).

INTRODUCTION.

In all highly specialized birds, and more particularly in those possessing great power of flight, such as the *Oscines*, the *Raptores*, and many of the *Anseres*, the various muscles are chiefly noted for their density, their dark carmine colour, and the distinctness between the fleshy portion and the tendinous. These characteristics are best seen in those groups of muscles which are brought into play during flight. As a rule, throughout the system, the tendons are very firm, dense, and of a bright pearly white colour ; and these, in the limbs especially, show a marked tendency to ossify.

Having obtained a fine adult Raven (or Crow), showing but few or slight injuries incident to its capture, and having *completely* and carefully plucked the specimen, it is to be immersed in 80 per cent. alcohol for at least forty-eight hours. The student then must supply himself with a large delf platter, for a dissecting tray ; a grooved director, a set of hooks and chain, a pair of wide-aperture spring forceps, and finally, three or four suitable scalpels of various sizes.

Everything being in readiness, the first object of

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our dissection will be to demonstrate and expose the cutaneous system of muscles, or the *dermal muscles.*

The dermal muscles are principally of two kinds: viz. the *dermo-osseous,* and the *true dermals.* The first-named have their origin on some part of the skeleton, and their insertion in the integuments; while the second kind both arise and are inserted in the skin or some of its appendages.

We never find all the known dermal muscles in any one form; they vary with certain characteristics of the bird. The Peacock has a special dermal muscle to act upon the gorgeous fan which it spreads, and is composed of the feathers of the lower part of the back.

Other birds having large crests, and peculiar skin developments about the head, which require special movements, possess the appropriate dermal muscles to operate upon them. Again, all birds possess an enormous system of minute muscles divided up into an infinite number of fasciculi, to harmoniously act upon the feather-quills, and collectively agitate the plumage. These are quite conspicuous in the Raven, but will not be especially dwelt upon. With an ordinary lens their action may be studied with comparative ease in one of the large quill-butts of the pinion, or tail.

In the Raven the *apteria* are entirely devoid of muscles, and even the other dermal muscles often appear to turn out of their usual direction to avoid these tracts.

The muscles may be arranged, according to the usual divisions of the body, into those of the cutaneous system; those of the head and neck; those of the trunk; those of the upper extremity; those of the lower extremity; and those devoted to the organs of special sense.

I. THE DERMAL MUSCLES.

1. TRUE DERMAL MUSCLES.	2. DERMO-OSSEOUS MUSCLES.
1. The dermo-frontalis.	2. The circumconcha.
4. The dermo-dorsalis.	3. The dermo-temporalis.
6. The dermo-tensor patagii.	5. The platysma myoides.
12. The dermo-humeralis.	7. The dermo-cleido dorsalis.
13. The dermo-pectoralis.	8. The cleido-trachealis.
	9. The dermo-spinalis.
	10. The dermo-iliacus.
	11. The dermo-ulnaris.

1. *The dermo-frontalis.*[1]—Carry an incision through the skin down to the bone, on the superior aspect of the head, parallel and close to the base of the upper mandible, extending completely across. Next, from the outer

[1] Selenka, in his classical work devoted to the anatomy of birds (Bronn's *Klassen und Ordnungen des Thier-Reichs,* Sechster Band. IV. Abth., Vögel : Aves. 3 u. 4 *Lieferung et seq.*), touches but lightly upon the dermal system of muscles in the Class ; while even those subsequent writers, Fürbringer and Gadow, in their well-nigh exhaustive memoirs in the same field, have by no means given us a complete history of this part of the myological system in Aves (Bronn's *Klassen,* vi. Band, 7–22 *Lieferung*). Such being the case, I find but few authors with whom I can compare notes, bibliographical or otherwise, upon the thirteen muscles described above as considered by me as belonging to the dermal system in *Corvus.* And I submit them for the most part as they were found to exist in the Raven,

end of this make an incision backwards down to the skull, and posteriorly to well expose the muscles in the upper part of the neck. This straight cut should pass about half a centimetre to the inner side of the upper eyelid of the same side. Reflect the flap of integument thus formed, covering the top of the skull, and carefully examine the under side of it in the median line, where it overlies the frontal region. In old male Ravens, I have here found a true dermal muscle, some 3 centimetres long, and a few millimetres wide, closely attached to the skin. So far, it has not been observed by me in female birds. By its contraction, the median feathers on the top of the head are made to lie very flat; at the same time those immediately above either eye are elevated, thus giving rise to lateral crests, which are quite well marked. In a captive Raven, an old adult male, I have seen the bird during certain moods make these crests stand up so as to be very evident, not to say conspicuous.

2. *The circumconcha.*—This is a dermo-osseous muscle which surrounds the periphery of the ear-conch. To expose it, join the longitudinal incision we have already made, and carry the scalpel just through the integument completely around the ear, a few millimetres without its thickened margin;—then dissect carefully up from all

simply inviting attention to the fact that my *dermo-temporalis* appears to be the second division of the M. CUCULLARIS of Gadow; the *dermo-dorsalis* being also a part of the same; while the *platysma myoides* of my list is the first division of the *m. cucullaris* of the same writer; and finally, my *dermo-tensor patagii* is the PARS PROPATAGIALIS of the M. CUCULLARIS of Fürbringer. The skin muscles in the neck of birds have been quite extensively divided up by Gadow and Fürbringer, described under a superficial and deep set, and in the main as constituting various parts of their *m. cucullaris* (Bronn's *Klassen*, vi. Band, 11 u. 12 *Lieferung*, p. 214).

sides towards it. As we detach the thickened portion just referred to, it will be found that it contains a dermal circular muscle, closely attached to the skin, but arising in an evident bundle of muscular fibres which have their origin at the outer terminus of the supraoccipital crest (Fig. 7, *c c*). The ear-conch is further supported by two ligaments, attached at anterior and superior points.

3. *The dermo-temporalis.*—Extend the longitudinal incision down the back of the neck to a point between the clavicular heads, carrying it just through the skin, and a few millimetres to the left of the median line. Carefully reflect back the entire flap, removing the skin from the throat and the anterior portion of the chest; and the alar and parapatagial duplicatures of the skin are also to be laid open. A number of dermal muscles are now exposed. One of the most important of these is the dermo-temporalis. On either side it is found to arise by a broad tendinous attachment from a small depression just above and anterior to the temporal fossa. The lower end of this attachment extends down over the sphenotic process, being but slightly wider than it above. From this origin the fibres of the muscle pass directly backwards as a rather broad flat bundle, and make some slight tendinous attachments with the temporal, which it covers. Once clear of the skull, this muscle, as a rather broad and thinnish band of delicate fibres, and intimately connected with the skin, passes directly down the side of the neck, being separated dorsad by quite an interval from the fellow of the opposite side, while anteriorly its margin tends to blend with the fibres of the cleido-trachealis; indeed a few of its fibres may run in to join this muscular fasciculus. Opposite the shoulder-joint in front the lower ends of the muscular fibres of the dermo-temporalis are lost upon the skin, or blend with the

fibres of the dermo-tensor patagii (to be described further along), or else, as I say, a few of them seem to merge with the cleido-trachealis. This muscle acts as a tensor of the lateral cervical integuments, and through its connection with the dermo-tensor patagii, as an auxiliary to the tensor patagii longus.

From such information as I have at hand at the present writing, I would say that the muscle I here describe corresponds to the temporo-alaris of Viallane, or at least to the upper portion of the temporo-alaris of that writer. It has also received other names at the hands of anatomists, as may be seen by consulting their works, or such as deal with the myology of birds.

4. *The dermo-dorsalis.*—I give the long muscular strip that we find in the Raven, in the median line, running down the neck and back, this name. It is most prominent in the middle of the neck, where it is inclosed in a fold of the integument. It gradually becomes lost as we approach the occiput, as it in like manner spreads out and disappears over the caudal region. Much fat may overlie it, which must be carefully dissected away to bring the muscle into view.

By its contraction the feathers along the median line of the dorsum and neck are raised, which action is assisted by the preceding muscle.

5. *The platysma myoides.*—This muscle is fairly well developed in the Raven, but requires careful dissection to bring it into view. It arises on either side, from the lower margin of the ramus of the jaw, below the ramal vacuity. From these points it spreads out as a very thin, fan-like sheath, closely attached to the skin, to meet in a faint raphe in the median line. It will be seen that the common muscular layer thus formed, materially assists in supporting the lingual apparatus and the upper

larynx, which are the chief structures found immediately above it. When this muscle contracts, these parts will be compressed and elevated.

6. *The dermo-tensor patagii.*—That duplicature of the common integument, of a triangular form, which is found in the Raven, as in other birds, between the root of the neck and the top of the shoulder, may be designated as the *parapatagium,* in contradistinction to the *propatagium,* or the alar integumental duplicature.

Lying within the free marginal fold of the parapatagial

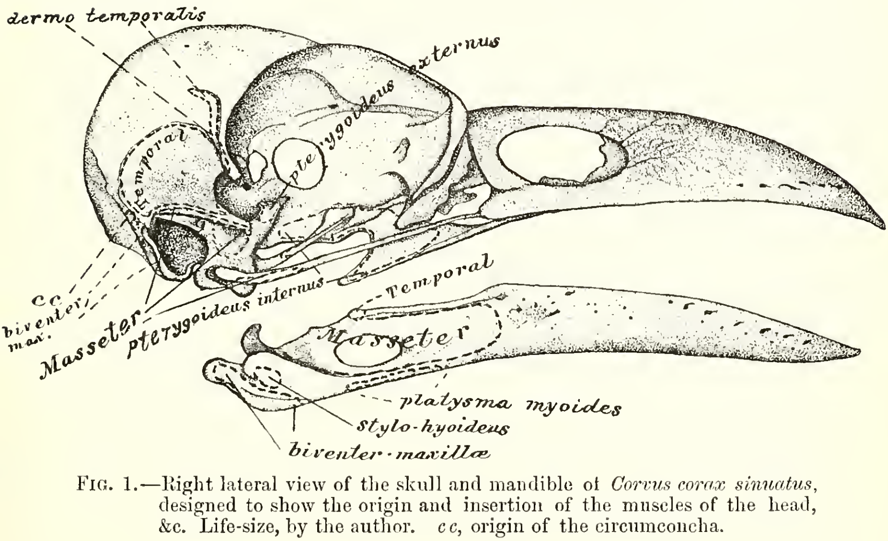

Fig. 1.—Right lateral view of the skull and mandible of *Corvus corax sinuatus,* designed to show the origin and insertion of the muscles of the head, &c. Life-size, by the author. *c c,* origin of the circumconcha.

duplicature in the Raven, we discover a well-developed bundle of muscular fibres, the mesial ends of which spread out, to either become, as a few of them do, inserted into the skin upon the antero-aspect of the root of the neck, or else pass obliquely upwards to blend with the fibres of the dermo-temporalis. This muscle I designate as the dermo-tensor patagii, and externally its

fibres converge, and opposite the outer carneous extremity of the tensor patagii longus they become converted into a small and delicate, though strong tendon, which soon thereafter blends with the tendon of the tensor patagii longus, and in its action plays the part of an auxiliary to it. The dermo-tensor patagii I have already alluded to in various publications, and find in my dissection of birds generally that it is quite a variable muscle; and were these variations all known and appreciated, I am confident that they would be characters of considerable taxonomic value. This muscle seems to correspond to the "pars propatagialis musculi cucullaris" of Fürbringer and Gadow, and has by several writers been described as occurring in the species representing a variety of orders of birds.

7. *The dermo-cleido dorsalis* (Fig. 8).—A beautiful pair of muscles exist in the Raven upon which I have bestowed this name. Either one arises from the upper and mesial aspect of a clavicular limb, to the extent shown in the drawing. As the muscle passes to the integument, it becomes closely attached to it, is directed over the shoulder-joint and scapular region in front, as three distinct fasciculi, diverging in a fan-like form. The extremities may meet in the median line of the dorsum to merge with the dermo-dorsalis.

It is very evident that the contraction of these muscles will brace the skin over the fore-part of the back, while if, on the other hand, they act from their integumental attachment, they may aid to a limited extent in the act of inspiration.[1]

[1] These muscles seem to fulfil, in part, the function of the *dermo-transversalis* of Owen, which I fail to discover in the Raven. This eminent authority describes this muscle for the *Apteryx* in the following words:—"The skin covering the dorsal aspect of the lower

8. *The cleido-tracheales.*—These muscles are highly developed in the Raven, and seem to take the place of the *sterno-maxillaris* of Owen.[1] Each arises from a

two-thirds of the neck, besides being acted upon by the *constrictor colli*, is braced down by a thin stratum of oblique and somewhat scattered fibres, *dermo-transversalis*, which take their origin by fasciæ attached to the inferior transverse processes of the sixth to the twelfth cervical vertebræ inclusive; the fibres pass obliquely upward and backward, and are inserted by a thin fascia into the median line of the skin covering the back of the neck" (*Anat. of Verts.*, vol. ii., p. 111).

The dermal system of muscles is highly developed in the *Apteryx*, and this may account for the absence of the *sterno-cervicalis* in such a form as the Raven, or its occurrence in a very rudimentary condition, which I failed to discover. The same author says:—"The *sterno-cervicalis* arises fleshy from the posterior incurved angular process of the sternum, from the ensiform prolongation and middle line of the outer and posterior surface of the same bone. The fibres pass forward, and, diverging in gently-curved lines, ascend upon the sides of the broad base of the neck, and are inserted by a thin but strong fascia into the median line of the dorsal integument. This muscle is a line in thickness at its origin, but becomes thinner as it expands; the anterior part is covered by the posterior fibres of the *constrictor colli*" (*loc. cit.*, p. 110).

Since writing this footnote I ascertain that the *sterno-cervicalis* of Owen is considered by Gadow to represent the deep layer of his *m. cucullaris* (Bronn's *Klassen des Thier Reichs*, vi. Band, p. 214).

[1] "The *sterno-maxillaris* [in the *Apteryx*] appears at first view to be the anterior continuation of the preceding [*sterno-cervicalis*], but is sufficiently distinct to merit a separate description and name. It arises fleshy from the anterior part of the middle line of the sternum, passes directly forward along the under or anterior part of the neck, expanding as it proceeds, and gradually separates into two thin symmetrical fasciculi, which are insensibly lost in the integument covering the throat and angle of the jaw. It adheres pretty closely to the central surface of the *constrictor colli*, along which it passes to its insertion. It retracts the fore-part of the skin of the neck, and also the head. Each lateral portion acting alone would incline the head to its own side; the whole muscle in action would

small circumscribed area situate upon the antero-inner aspect of the middle of either limb of the furcula as a rounded, though not large, bundle of muscular fibres. They take their course directly up the neck, separated by quite an interval. About the middle of their path, they each flatten out and become intimately attached to the skin and the dermo-temporalis muscle. Further along, they become gradually narrower again, and are finally inserted, touching each other by their inner borders, on the anterior aspect of the superior larynx, the trachea, and the skin over these parts. It is only for about their middle thirds that they may be considered as true dermal muscles, and thus account for their appearance in the present category. By their acting in common, or each in turn, movements of the parts would result similar to those described by Professor Owen for the *sterno-maxillaris* (see footnote, *anteà*).

The longitudinal incision which we made down the back of the neck must now be extended, passing only through the skin, to the distal tip of the pygostyle.

bend the neck; but the movements of the head and neck are more adequately and immediately provided for by the appropriate deeper-seated muscles, and the immediate office of the present muscle is obviously connected with the skin. Nevertheless, in so far as this muscle acts upon the head, it produces the same movements as the *sterno-mastoideus* in Mammalia" (*loc. cit.*, p. 111).

Since writing the footnote just quoted from Owen, I have ascertained (Bronn's *Klassen des Thier-Reichs*, vi. Band, pp. 214, 215) that Professor Gadow considers the *constrictor colli* of Owen to be the superficial layer of the muscle called the *cucullaris* by Professor Fürbringer and adopted by himself, while the *dermo-spinalis* of Owen constitutes the third division of the same muscle, or the *m. cucullaris, pars propatagialis*, of Fürbringer, which, as I have above remarked, is my *dermo-tensor patagii.*—R. W. S.

Reflect back on either side the integumental flaps, as far as the sides and the limbs. Several muscles of the cutaneous system are now exposed in this region.

9. *The dermo-spinalis.*—This delicate muscle is but

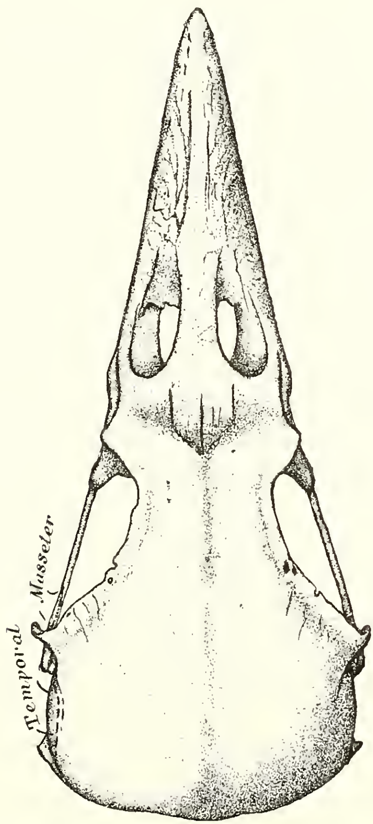

FIG. 2.—Superior aspect of the skull of Raven, adult ♂, life-size. Mandible removed. Shows the upper edge of the insertion of the temporal muscle, and that part of the masseter which arises on the zygoma.

feebly developed in the Raven, but a little staining in old males will usually bring its fibres into view. It arises in an attenuated fascia from the crests of the

neural spines of the first, second, and third dorsal vertebræ, the fibres pass directly outwards, closely attached to the skin, in rather a broad pale stratum, to be lost over the scapular region on either side of the body.

10. *The dermo-iliacus* is a parial muscle, either one of which arises fleshy from the inner angle of the emarginated portion of the antero-dorsal border of the ilium. The fibres pass directly forwards, as a narrow ribbon, to spread out as a thin integumental layer, to be lost over the region of the shoulder-blade. These last two muscles acting from their points of origin would so pull the skin as to cause the feathers attached to it to lie flat, or closer to the body, over the parts where they are severally distributed. In this way they antagonize some of the muscles described above, as, for example, the *dermo-dorsalis*.

11. *The dermo-ulnaris*[1] is exposed by still further reflecting the skin. It is a very prominent muscle, and

[1] This muscle is the PARS METAPATAGIALIS of the M. SERRATUS SUPERFICIALIS *s.* THORACI-SCAPULARIS of Fürbringer, and also of Gadow (Bronn's *Klassen*, vi. Band, p. 221), and represents the *tensor membranæ posterioris alæ* of Wiedemann and Tiedemann, of Rüdinger, of Selenka, and of Carlsson, while Schöpss described it in part as the *m. plicæ alaris posterioris.* Of it Gadow has said :—"III. *Pars metapatagialis.* Dieser Theil ist nach Fürbringer als aberrirende zur Haut gehende Lage des Serrat. post. aufzufassen. Er entspringt mit zwei oder drei, selten mit nur einer Zacke zusammen mit den Bündeln der Pars post. serrati von den Rippen, heftet sich an die Hautduplicatur zwischen Oberarm und Rumpf und verliert sich an den oberen Schwungfedern zweiter Ordnung. Der Muskel is demnach ein Theil des weiter unten als *M. metapatagialis* zusammengefassten Flughautspanners. Er findet sich bei Gallus, Anser, Cygnus, Fulica, Otis, Psittacus, Raptores, Corvidæ, u.s.w., fehlt aber den Spheniscidæ, Tubinares, Ratitæ" (Bronn's *Klassen*, vi. Band, p. 224).

one of the most conspicuous of the cutaneous system. It arises by a thin fascia from the outer aspects of the third and fourth true vertebral ribs, at the bases of their epipleural appendages, and from the fascia between them. From this point it passes forwards and upwards as a thick muscular bundle, loosely attached to the skin, until it arrives in a point at the inner end of the integumental duplicature behind the humerus. Here it becomes a small and slender tendon lying between these skin flaps in the line of their posterior margin, as far as the elbow-joint, where the tendon spreads out to become attached to the fascia in the locality, and covering the olecranon of the ulna. By extending the elbow-joint it assists in elevating the wing.[1]

12. *The dermo-humeralis*[2] arises as a broad but

[1] Owen describes for the *Apteryx* a *dermo-costalis* which "arises fleshy, from the costal appendages of the seventh and eighth ribs. The fibres pass forward and join those of the preceding muscle [*dermo-iliacus*] to be inserted into the scapular integument" (*Anat. of Verts.*, vol. ii., pp. 111, 112). I made several special dissections for the very purpose of finding this muscle in the Raven, but my investigations lead me to believe that it does not exist in our present subject.

[2] Fürbringer and Gadow have divided the M. PECTORALIS into three parts, and the *dermo-humeralis* as here described for the Raven corresponds to the third part, or the PARS ABDOMINALIS (Fürbringer).

Gadow presents us with the synonymy of the *dermo-humeralis* as follows :—

"III. *Pars abdominalis* (Fürbringer).
Subcutaneus abdominalis. Wiedemann, Tiedemann, § 100, No. 5.
„ „ Watson, p. 55.
Subcutaneus thoracis. Tiedemann, § 100, No. 4. Prechtl, § 71.
Ohne Namen erwahnt. Schöpss, p. 112.
Dermo-humeralis. Owen, p. 24.
Panniculus carnosus (second portion). Reid, p. 139.
Muscle des parures. Gervais et Alix, p. 401.
„ „ Watson, p. 81."

barely perceptible fan-like muscle in the abdominal integument. This is soon gathered, as it passes forwards and upwards, towards the head of the corresponding humerus, into a decided, long narrow fasciculus of fibres, to be finally inserted by a very pretty little fan-like expansion of thin glistening fascia into the tendon of the pectoralis major just below its insertion. In the *Apteryx* the *dermo-humeralis* "is inserted fleshy into the proximal part of the humerus" (Owen). In either case it depresses the humerus in the last-named bird by acting directly upon the bone, while in the Raven it is an auxiliary to the great pectoral muscle.

13. *The dermo-pectoralis* is a muscle that corresponds to the *dermo-dorsalis* of the back, and is simply the evident muscular stratum underlying the feather-quills of the tracts of these appendages, that are found on either side of the robust chest of this bird, running in the longitudinal direction.

Either of these muscles disappears anteriorly over the origin of the cleido-trachealis, while behind their terminal fibres merge imperceptibly into the integument after passing the hinder tips of the postpubic elements of the pelvis. Acting from the anterior skin insertion, these muscles raise the feathers of the chest, the action being reversed by the muscle contracting from the opposite extremity.

II. THE MUSCLES OF THE HEAD.

INCLUDING THE MUSCLES OF THE LINGUAL APPARATUS, TRACHEA, AND THOSE OF THE EYE AND EAR.

Divide the skin completely around the entire beak, at its base; divide the platysma myoides close to its origin, on either side, and allow its gular portion to come away with the integument as it is removed; in like manner, divide, on either side, close to their origins, the circumconchæ and dermo-temporalis. Carefully reflect backwards the entire skin, so as to expose the neck for at least its upper third. Open the bird's mouth to its full extent, and pack sufficiently with soft tow, so as to render the muscles of the tongue and trachea more prominent.

The muscles here to be examined are the intrinsic muscles of the head, and are in no way attached to the vertebral column. They are the following:—

14. The temporal.
15. The masseter.
16. The biventer maxillæ.
17. The entotympanicus.
18. The pterygoideus internus.
19. The pterygoideus externus.
20. The digastric.[1]

[1] This group of muscles (14–20 inclusive) are presented by Gadow in his well-known memoir on the morphology of Aves in Bronn's *Klassen*, vi. Band, pp. 318–325, where they are illustrated by

14. *The temporal.*—To thoroughly expose this muscle we must divide the strong lateral ligament of the jaw, which is attached above the tip of the squamosal process, and below to the outer side of the articular end of the mandible. The dense fascia encasing the temporal should also be largely dissected away.

The bulk of this fan-shaped muscle will be found attached to, and occupying the entire temporal fossa. Anterior to this, some of its more fleshy fibres arise from the mesial side of the sphenotic process, and the adjacent wall of the orbit. From this extensive origin the fibres converge as they pass downwards and forwards, blend more or less completely with the fibres of the masseter as they come opposite to them, to finally become tendinous, to be inserted in the coronoid process upon the superior ramal margin of the mandible.

15. *The masseter* (Figs. 1 and 7).—This muscle, which may be considered a powerful auxiliary to the one just described, is in the Raven divided into two distinct portions. The greater mass arises by a broad and thin tendon from the entire length of the bony ridge above the auditory entrance, and the squamosal process

numerous handsome and useful figures on plates, and an extensive synonymy is given, the latter being somewhat too extensive to reproduce in the present connection. He divides his M. DIGASTRICUS S. DEPRESSOR MANDIBULÆ into three portions (*a*, Äussere Portion; *b*, Mittlere Portion; and *c*, Innere Portion), and separately defines them. The temporal has also been somewhat similarly dealt with, having been divided into four portions, with an accessory part.

The pterygoidal muscles are given under a single caption, the MM. PTERYGOIDEI. Numerous prominent writers have been omitted in so far as the synonymy goes, though the subject of these head-muscles has been carefully handled by the author in question.

In my description above, I have essentially adopted (for the present) the nomenclature of Owen (*Anat. Verts.*, vol. ii.), though subsequent dissections may incline me to alter or abandon it.

which extends it. It also has a fleshy attachment to the outer aspect of the body of the quadrate bone. As it passes downwards and forwards beneath the zygoma, it

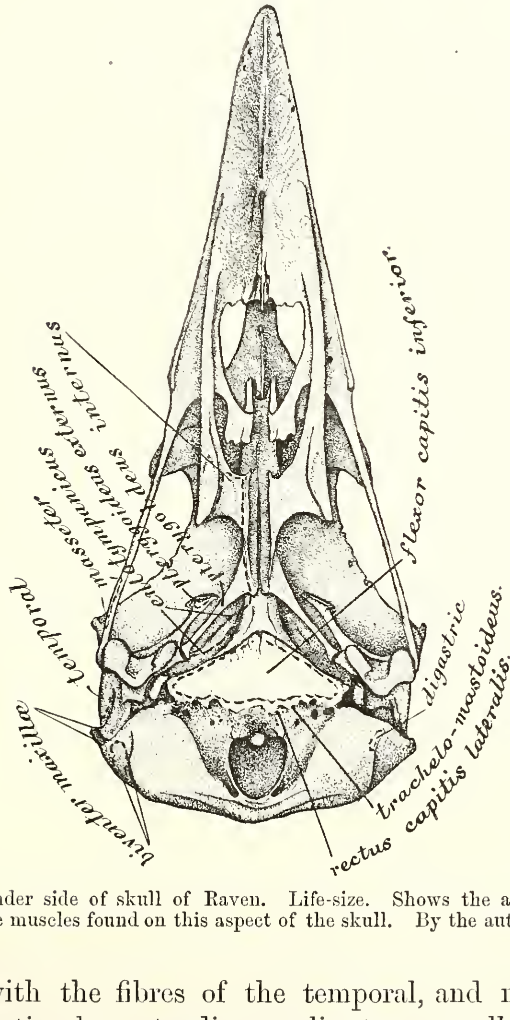

FIG. 3.—Under side of skull of Raven. Life-size. Shows the attachment of the muscles found on this aspect of the skull. By the author.

blends with the fibres of the temporal, and makes its first insertion by a tendinous slip to a small tubercle, situated on the upper border of the jaw, behind the

coronoid process. The great bulk of this division of the muscle, however, passes on to be inserted, fleshy, on the outer side of the ramus of the mandible, nearly as far forward as the horny beak, while behind it is bounded by the prominence of the articular extremity (Fig. 7). Quite a dense fascia encases this division of the muscle.

The smaller part of the masseter arises, rather fleshy, from the side and under border of the hinder fourth of the zygoma. This auxiliary and spindle-shaped slip terminates behind in a small, though strong, tendon, which is inserted into the mandible on its upper border, immediately in front of the articular end (Fig. 5, *m′*). The contraction of this part would draw the jaw against the quadrate, and, to a limited extent, close it. This last action, however, is powerfully effected by the united contraction of the temporals and masseters.

Owen says :—" In the Cormorant, the osseous style, movably articulated to the superoccipital, affords to the temporal muscles a more extensive origin. This, indeed, is its essential use, for the muscles of the upper part of the neck are inserted into the occipital bone, and glide beneath the posterior or super-added fasciculi of the temporalis."

16. *The biventer maxillæ*, on either side, is that muscular mass which covers the mandibular articulation behind. It arises above from two points, viz. the ridge bounding the hinder part of the osseous ear, and secondly the depression to its mesial side. The two heads almost immediately blend as they pass downwards and forwards, as a curved fleshy mass, to become inserted into the posterior aspect of the articular end of the mandible, including the angle (Figs. 4 and 7). To study this muscle properly it should be transversely divided across its belly at about its middle; the two extremities may

then be easily dissected up,above, to its origin; below, to its insertion.

The relations of this group, the openers and closers of the jaw, to the surrounding structures, as the ear, the dermo-temporalis muscle, and the quadrate, should be carefully examined.

To expose the next set, divide the biventer maxillæ as already directed, say on the right side; cut the corresponding tendon of insertion of the temporal; divide the masseter as its origin; and finally disarticulate the man-

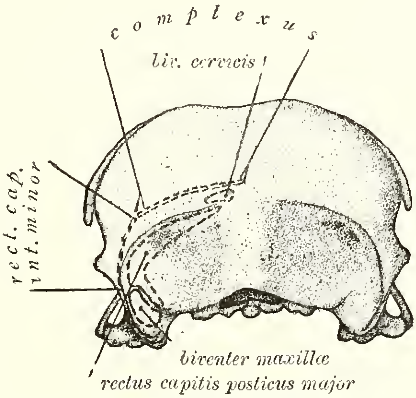

FIG. 4.—Posterior view of skull of Raven. Life-size. Shows the origin of the muscles upon this aspect. After nature, by the writer.

dible, lifting the cranium so that we have a plain view of its under side. Matters may be somewhat improved, too, by severing the zygoma at its middle, and pulling the extremities upwards.

17. *The entotympanic* is a small, spindle-shaped muscle, which arises quite fleshy from the side of the basisphenoid, and to a limited extent from the base of the rostrum immediately beyond it. As it passes backwards and downwards, it rapidly contracts to form

a double tendinous slip. One of these is inserted into a little spine-like process on the upper side of the shaft of the corresponding pterygoid, close to its quadratal articular end. The other is inserted into the quadrate itself, close to the pterygoidal articulation, and to its outer side.

When these muscles contract, they pull forward the quadrates and pterygoids, which latter, in pushing against the palatines, tend to raise the superior mandible.

18. *The pterygoideus internus* forms, with the aid of its fellow, the great muscular mass which is found at the roof of the mouth. It has a very extensive origin. On the upper side of the palatine the fibres arise over nearly the entire surface, at first fleshy, to become tendinous along the hinder margin of the bone. Similarly, on the inferior aspect they fill the fossa there found. As the fasciculi of this muscular mass pass backwards and outwards, they are augmented by others, which find their origin upon the distal head and shaft of the corresponding pterygoid and the sphenoidal rostrum for some distance behind it. The fibres converge moderately, to make an extensive tendinous insertion upon the antero-internal aspect of the articular end of the mandible. Mesially, they are carried out to the extremity of the inturned tip, where the tendon is very strong; while beyond they encroach slightly upon the ramus, where the insertion is more of a fleshy character (Figs. 5 and 6).

19. *The pterygoideus externus* is an exceedingly neat and well-defined muscle. It arises from the outer aspect of the extremity of the orbital process of the quadrate. The fibres form a roundish bundle, and slightly diverge as they pass forwards, downwards, and

outwards, to insert themselves upon the inner aspect of the mandibular ramus, filling the fossa found in front of the articular enlargement, and in which we find the ramal vacuity. This latter foramen is closed in by the pterygoideus externus in this situation, while outwardly the masseter covers it up, the two muscles at this point being practically in contact.

20. *The digastric* arises on either side from an elliptical, longitudinal space, of no great size, situated at the base of the cranium, on the externo-lateral angle of the

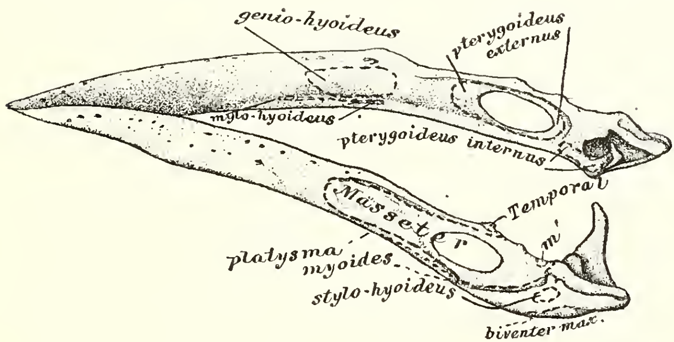

FIG. 5.—Left lateral aspect of mandible of *Corvus corax sinuatus*, slightly tipped forwards to show muscular attachment on inner side. Life-size. *m'*, the point of insertion of the zygomatic division of the masseter.

basitemporal (see Figs. 7 and 11). From this origin the muscle passes down the side of the neck as a thin, narrow band of fibres. Opposite the angle of the jaw these begin to diverge, and spread out in a fan-like form, to meet a corresponding expansion of the opposite muscle in a median raphe, which extends longitudinally over the superior larynx. They are still more definitely inserted into the cartilaginous continuation of the second basitemporal about its sides. The middle portion of this extremely attenuated muscular stratum is very

difficult to thoroughly trace in the younger specimens of Ravens, and it admits of our seeing the underlying structures through it. The delicate fibres of the platysma myoides overlie it, while its anterior fasciculi blend with those of the mylo-hyoideus.

According to Mivart, in birds and reptiles the digastric descends from the hinder part of the cranium to the posterior end of the mandible, and in some birds is divided into three portions (*Elem. Anat.*, p. 313). As we have just seen, it is still different in the *Corvidæ*.

The chief use of this muscle would seem to be to raise the hyoid apparatus and trachea against the pharynx, after a morsel of food has passed that point, to prevent its return to the mouth, and assist its passage down the œsophagus.

III. THE MUSCLES OF THE TONGUE.

In this section I will speak of those muscles of the Raven which I have found upon dissection to be, in

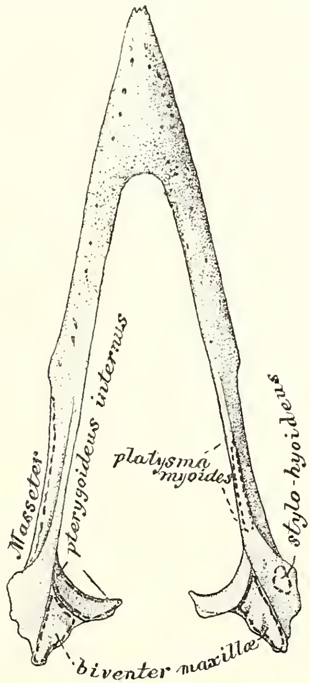

Fig. 6.—Under side of mandible of a Raven, designed to show the sites of muscular attachment; life-size, from the author's dissections.

some way or another, attached to the hyoidean apparatus, and involved in its movements.

In Fig. 7, and other illustrations to this work, I have made careful drawings of these parts, and endeavoured to present this group of muscles in such a manner as they can best be seen and studied.

The following are presented for our examination :—

21. Mylo-hyoideus.	25. Sterno-hyoideus.
22. Stylo-hyoideus.	26. Depressor-glossus.
23. Genio-hyoideus.	27. Cerato-glossal.
24. Cerato-hyoideus.	

21. *The mylo-hyoideus*[1] (Figs. 5, 11, and 17).—This muscle arises on the inner side of the mandible, just above

[1] Professor Hans Gadow sees two parts to the *mylo-hyoideus* in birds, his M. MYLO-HYOIDEUS ANTERIOR corresponding to my *mylo-hyoideus*, as shown by me in Fig. 11 of the present work (see Bronn's *Klassen*, vi. Band, pp. 304–307).

To me, the M. MYLO-HYOIDEUS POSTERIOR of Gadow did not seem to be sufficiently evident in the Raven to merit a separate description, and it is in no way so distinct a muscle as he figures it in *Rhea darwini* (*l.c.*, Fig. 1, M.H.*p.*, p. 306).

Nevertheless, it has been variously considered by other anatomists, and Gadow offers us the following synonymy and remarks thereon :—

"103. I. Grupe des M. MYLO-HYOIDEUS.

103A. M. MYLO-HYOIDEUS ANTERIOR.

M. genio-hyoidean. Vicq d'Azyr, 1773, p. 585, No. 1.
Mylo-hyoidean. Cuvier. Duvernoy, p. 5, No. 1.
,, Gervais et Alix, p. 19.
Mylo hyoideus transversus. Tiedemann, § 90, No. 1.
,, ,, Nitzsch, p. 134, No. 2.
Mylo-hyoideus obliquus. Kutorga, p. 20.
Rhomboideus juguli. Wiedemann, p. 70.
Querer Unterkiefermuskel oder vorderer, oberflächlicher Kiefer-Zungenbeinmuskel. Meckel, p. 409, No. 2.
Mylo-glossus s. transversus mandibulæ. Gurlt, p. 14.
Mylo-hyoideus. Schneider, p. 145 ; Gadow.
,, Watson, p. 136.

"Dieser Muskel erscheint nach Abtragung der Haut zwischen den beiden Unterkieferästen. Er entspringt von der Innenfläche, oder

the lower border and the inturned edge of the horny sheath of the bill. The line of its origin occupies about

auch vom Rande des Unterkiefers mit ganz quer gerichteten Fasern, die sich in der Mittellinie mit denen der anderen Seite unter Bildung eines longitudinalen Sehnenstreifens vereinigen. Gewöhnlich hat der Muskel keine direkte Verbindung mit dem Zungenbein." [This is followed by an account of its variations in a number of groups of birds.]

"103B. M. MYLO-HYOIDEUS POSTERIOR.

Mylo-hyoïdien. Vicq d'Azyr.
Serpi hyoïdien. Cuvier.
,, Duvernoy.
Retrahens linguæ. Wiedemann, p. 71.
Mylo-hyoideus obliquus. Tiedemann, § 90, No. 2.
,, ,, Kutorga, p. 20.
,, ,, Nitzsch, p. 135, No. 4.
Heber des Zungenbeins. Meckel, p. 409, No. 1.
Mylo-hyoideus. Gurlt, p. 14.
Retractor de l'hyoide ou serpi-hyoïdien. Gervais et Alix, p. 18.
Serpi-hyoideus + *Stylo-hyoideus.* Gadow, pp. 66, 67.
Retractor linguæ. Watson, p. 135.

"Halswärts vom *M. mylo-hyoideus*, ebenfalls subcutan gelegen zerfällt dieser, grosser Verschiedenheiten zeigende Muskel, bisweilen in zwei Theile. Bei *Rhea darwini* entspringen beide zusammen von der Aussenfläche des hinteren Ende des Unterkiefers, laufen über die nach Aussen übergreifende Insertion des *M. pterygoideus*, werden breiter und theilen sich in eine vordere und eine hintere Masse. Die letztere (*M. serpi-hyoideus*) geht mit ziemlich transversaler Richtung zur Mittellinie; ihre tieferen Züge befestigen sich am Bindegewebe der Ventralfläche des Larynx, die oberflächlichen vereinigen sich aponeurotisch mit denen der anderen Seite und strahlen zugleich auf den Hinterrand des *M. mylo-hyoideus*, sowie halwärts auf den *M. constrictor colli* aus. Die vordere Masse (*M. stylo-hyoideus*) ist schmaler, geht schräg vorwärts und einwärts und inserirt sich in dem von den beiden Zungenbeinhörnern und dem Zungenbeinkörper gebildeten Winkel; der Insertionstheil wird ventralwärts vom *M. mylo-hyoideus* anterior bedeckt."

After giving its variations in a number of groups of birds he adds that "Bei *Corvus* kommt der gemeinsame Ursprungstheil

the anterior third of the entire length of the ramus, and is carried forward to the posterior margin of the horny covering of the beak, where the latter overlaps the symphysis. Its wonderfully delicate fibres are directed transversely to meet those of the muscle coming from the opposite side. The two unite in a mid-longitudinal raphe, which as it is produced backwards becomes faintly tendinous, and is finally inserted as an attenuated aponeurosis into the under side of the hyoid, between the first and second basibranchial, in the middle line (Fig. 17).

The thin sheet of muscle thus formed spans and stretches completely around the forepart of the interramal space, and by its contraction the tongue is lifted upwards against the roof of the mouth.

This muscle is well developed in other classes of animals. Professor Mivart found it very large in *Menopoma*, and it varies considerably among the higher Mammalia.

22. *The stylo-hyoideus* is the name used by Professor Owen for a muscle which is quite conspicuous in the Raven. Its origin and insertion are well shown in Fig. 7, where the lingual apparatus is drawn down by the dissecting chains, in order to put it on the stretch (see various views of the mandible, where it is shown).

The stylo-hyoideus arises on the outer aspect of the articular enlargement of the mandible, at about the middle point. Its fibres form a rather long, transversely

hauptsächlich von der äusserlich den *M. biventer mandibulæ* bedeckenden Fascie."

Having carefully dissected the *mylo-hyoideus* out in some fifteen specimens of the Raven, it seems but proper that I should say here that my observations upon it agree with those of Owen, and in the form in question I have thus far failed to detect a posterior *mylo-hyoideus* (see Owen's *Anat. Verts.*, vol. ii. p. 153).

flattened fasciculus, which proceeds downwards and forwards to be inserted by a delicate tendon into the head of the cerato-branchial of the thyro-hyal of the corresponding side on its upper aspect. When these muscles contract in unison, they tend to raise the tongue towards the palate, but if they act singly this member is pulled to the side towards which the contracting muscle is directing it. We find that "in some birds it divides into three or more portions: the *posterior* descends obliquely forward, and is inserted into the tendinous commissure of the mylo-hyoideus; the *middle* portion is inserted into the urohyal [second basibranchial]; the *anterior* fasciculus is inserted into the side of the basihyal above the transverse hyoglossus. The actions of these different portions vary according to their insertion; the first and second depress the apex of the tongue by raising the urohyal, the third raises the tongue and draws it to one side when it acts singly" (Owen).

23. *The genio-hyoideus* is the largest and most powerful muscle of the group we are now examining (Figs. 5 and 7, and others). It arises from an extensive area (two in some birds) on the inner side of the mandible nearly as far forward as the horny part. The fibres unite to form a broad band, transversely compressed, which passes downwards and backwards until it meets the outer side of the corresponding thyro-hyal, about its middle; this it envelops, by a spiral turn and a half, to its very extremity.

It is quite evident that the contraction of this pair of muscles will have the effect of protruding the tongue from the mouth.

24. *The cerato-hyoideus* (Figs. 7 and 9).—I find the muscle so named by Owen to have a somewhat different insertion than that eminent anatomist gives it for

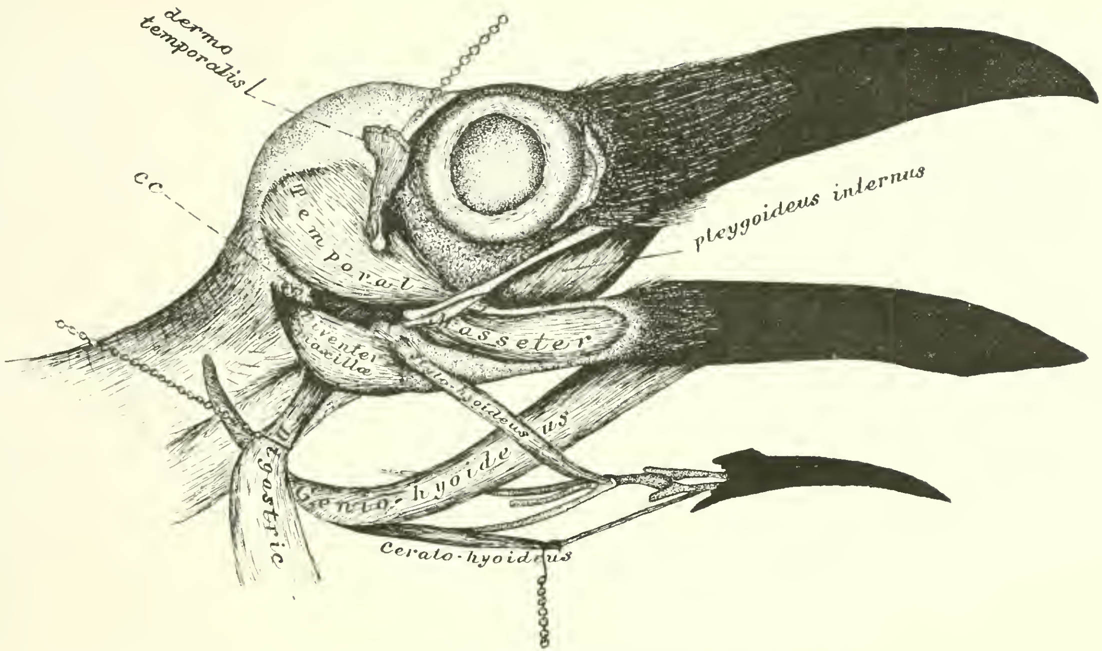

Fig. 7.—Right lateral view of head of a Raven, which has been dissected to show the muscles upon this aspect, as well as those of the hyoid. Small dissecting chains forcibly pull down the tongue, pull up the constrictor colli, and pull aside the digastric. The two divisions of the masseter are well shown, and the lateral ligament of the jaw has been removed, the better to show the temporal muscle. The horny coverings of beak and tongue have not been taken off, and the thinner extension of the former still remains intact over the pterygoideus internus. *c c*, origin of circumconcha. Drawn by the author from his own dissections. Figure size of life.

the class, generally. Of it, he says that "it passes from the thyrohyal to the urohyal, and is therefore subservient to the lateral movements of the tongue" (*Anat. Verts.*, vol. ii. p. 154). This duty it also performs in the Raven, where we find it arising on the under side of the shaft of the epibranchial element of the thyro-hyal by a delicate tendinous slip. This soon becomes muscular as it passes forwards, forming a long slender belly, which is closely applied to the hyoid. Opposite the first basibranchial it is again a long tendinous slip, and thus remains until it is finally inserted into a little bony elevation on the under side of the anterior end of the corresponding cerato-hyal.

Owing to the free lateral movements enjoyed by the joint at the anterior end of the first basibranchial, it is quite clear that either of these muscles acting singly must pull the tongue to one side. But the joint referred to also operates in the opposite direction, so that, united action of the pair would tend to depress the tongue.

25. *The sterno-hyoideus* (Figs. 9 and 17).—Agreeing with the majority of birds, we find in the Raven either sterno-hyoideus arising from the anterior surface of the thyroid bone of the superior larynx. The muscular fibres at the origin are quite fleshy, but as they converge and pass forwards, they become rather more tendinous, and are thus constituted as they are inserted into either cerato-hyal at its base. Other fibres, which hold a more mesial position, unite with the corresponding ones of the muscle of the opposite side, to pass into and finally be lost in the tissue composing the soft part of the tongue, at its base. These latter are not well shown in Fig. 17, as they are huddled together by the traction of the little dissecting hook and chain, which pulls the muscle to one side so that the depressor glossus may be seen.

If these muscles contract in unison, the larynx being the fixed point, they will evidently depress the tongue. Acting singly in the same way, either one will likewise depress the tongue, but also give it a lateral deflection to the side towards the muscle which is contracting.

If they contract together, with the base of the tongue as the fixed point, they will pull the larynx forwards, a very necessary movement during the accomplishment of the act of deglutition.

26. *The depressor-glossus* is the name I have bestowed upon a small but important muscle which Professor Owen describes in the following words: "A small and short muscle, which is single or azygos; it passes from the basihyal to the under part of the glossohyal; it depresses the tip of the tongue and elevates its base" (*loc. cit.*, p. 154). Nameless though he left it, Professor Owen's description answers very well indeed for a corresponding muscle that we find in the Raven, and the one, as I say, I propose to call the *depressor-glossus.* In this bird it arises fleshy over the entire under surface of the first basibranchial (basihyal of Owen), the fibres contract as they pass forwards, and become tendinous between the tongue bones, and as a delicate tendon so continue on to finally find an insertion at their tips, where they meet anteriorly (Fig. 17). When this muscle contracts, the tongue must behave in a manner already described, and quoted from the authority above.

27. *The cerato-glossus* is a small muscle we find on the upper side of the hyoid, one on either cornua. Each occupies, as an origin, the half of the surface of the first basibranchial. After passing over the joint formed by the head of the thyro-hyal, the fibres become more tendinous, as they insert themselves along the upper side of the shaft of the cerato-branchial element. They

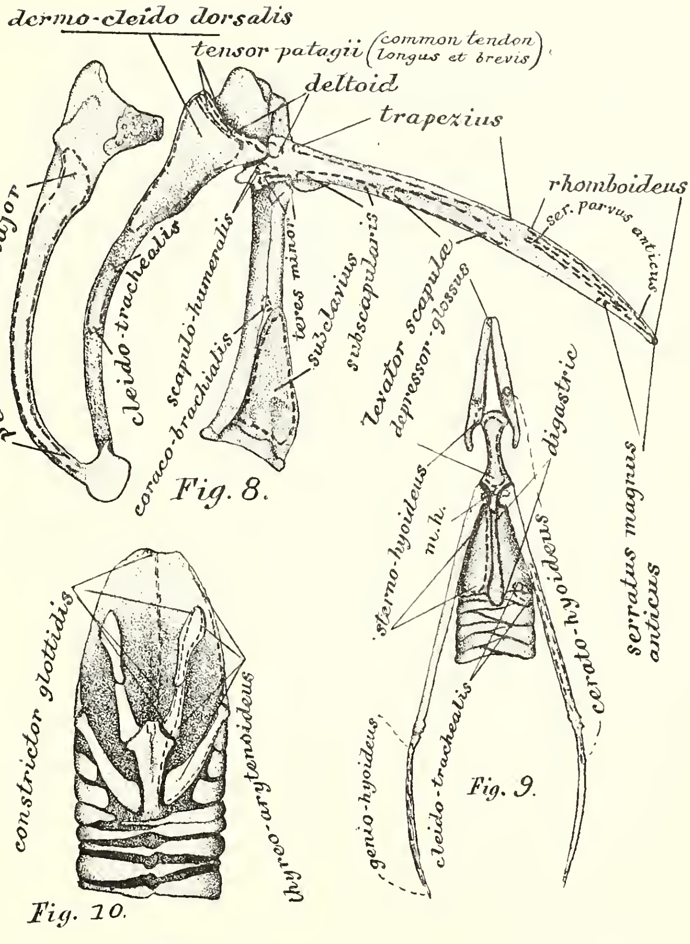

FIG. 8.—Oblique view from the inner side of the furcula, coracoid, and scapula of the Raven, showing the areas devoted to the muscles which take origin from these bones. Life-size.

FIG. 9.—Under view of the hyoid arches of a Raven, with the upper part of the windpipe, *in situ*. Designed to show the origin and insertion of certain muscles of the tongue. *m.h.*, lingual attachment of the *mylo-hyoideus*. Life-size.

FIG. 10.—Superior view of the bones of the upper larynx and half-rings and rings of the trachea. Shows the origin and insertion of the two muscles which control the rima glottidis. × 2. All the figures drawn by the author from his own dissections.

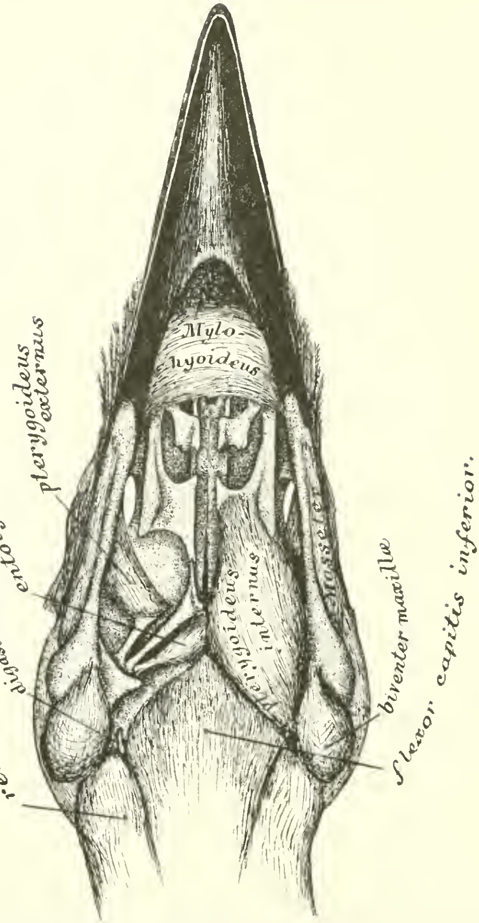

Fig. 11.—Under view of the head of a Raven, with mandible *in situ*, but with hyoid apparatus and other parts carefully removed. Dissected to show the muscles which occur upon this aspect; the left side (the right in the figure) shows the origin and insertion of the *pterygoideus internus*. The opposite side is dissected to show the *entotympanicus* and *pterygoideus externus*. The anterior two-thirds of the *mylo-hyoideus* is also shown, and its mode of attachment. The *digastric* is cut off close at its point of origin. This figure should be carefully compared with Fig. 3 of the present memoir. Life-size, by the author from his own dissections.

here glide beneath the thyroid bone of the superior larynx. Just beyond this point they become fully

tendinous, and are finally inserted as a distinct tendon at the muscle's termination on the shaft of the element just alluded to, and in line with the last-named fibres.

According to Professor Owen, Dr. Salter proposed the name of this muscle which I have here adopted for it. The former anatomist describes it as "a short muscle, which arises from the junction of the basihyal with the urohyal, and is inserted into the thyrohyal" (*loc. cit.*, p. 154).

Professor Owen figures it in a Fieldfare, but makes an incorrect reference to his figure, and the muscle is shown, apparently, as being pulled out of its normal position, in order to show the stylo-hyoideus.

When these muscles contract, they will elevate the long cornua of the hyoid arches, and press them up against the skull.

In addition to the muscles already described as belonging to the tongue, there is still another pair, found by Owen in a Woodpecker (shown in Fig. 12 at *h*), which he has named the *cerato-tracheales*, and says: "They arise from the trachea about eight lines from the upper larynx, twist four times spirally round the trachea, and then pass forward to be inserted into the base of the thyro-hyals. This is the principal retractor of the singular tongue in this species" (*Anat. Verts.*, vol. ii., p. 154).

Unfortunately, Professor Owen does not mention in his work the species of Woodpecker in which he found this interesting pair of muscles. He speaks of it, however, in such a way as to lead one to suppose that it occurs throughout the family. Dissections made upon our American forms, with a view of looking further into this matter, would be well worth the time and labour of the comparative anatomist.

Referring again to Professor Gadow's estimable work in Bronn's *Klassen des Thier-Reichs* (vi. Band, pp. 307–317), we find that he has described and proposed the following nomenclature for the muscles of the lingual apparatus in birds. In presenting this I refer to the plates of this writer, although his figures are not here reproduced. It will be observed that he has bestowed very different names upon the muscles as compared with Owen's nomenclature, the authority at my hand when the present volume was written.

"II. Muskeln des Zungengerüstes. (Taf. xxxii., xxxiii., und Holzschnitte.)

"104. SYSTEM DES M. STERNO-HYOIDEUS.

Thyreo-hyoideus. Vicq d'Azyr ; Gervais et Alix, p. 18.
M. laryngo-hyoïdei. Tiedemann, § 90, No. 5.
Hyo-thyreoideus. Kutorga, p. 20. Gurlt, p. 15.
Thyreo-hyoideus. Nitzsch, p. 136, No. 5.
Thyreo-glossus. Nitzsch.
Thyro-hyoid. Watson, p. 136.
M. ypsilo-trachealis s. depressor arteriæ asperæ superficialis, major. Meckel, 6 Theil, p. 284.
Sterno-hyoideus. Nitzsch ; Gurlt, p. 15.
Tracheo-sternalis. Gadow, Tenuirostres, p. 68.
Omo thyreoidei. Huber.
Les cerato trachées. Cuvier.
Cerato-trachei. Tiedemann, p. 122.
Tracheo-glossi. Huber.
Cerato-trachealis. Owen.
Tracheo-hyoïdien. Duvernoy.
Tracheo-hyoideus. Gadow, p. 62.

"Ein echter, an das bei den Reptilien allgemeine ursprüngliche Verhalten anschliessender *M. sterno-hyoideus* ist noch bei *Apteryx* vorhanden. Der breite Muskel entspringt vom vorderen Rande der Unterfläche des Thyreoid-Knorpels des oberen Kehlkopfes und vom ganzen Innenrande der Zungenbeinhörner. Seine Fasern sind abwärts gerichtet, verbinden sich theilweise mit denen der anderen

Seite in der ventralen Mittellinie und bilden dann eine ziemlich dicke und breite Muskellage, welche ventral und seitlich die Trachea lose umgiebt, ohne jedoch an derselben befestigt zu sein. Nahe der Brust angelangt, theilt sich die bis dahin vereinigte Masse in eine rechte und eine linke Hälfte, deren jede sich am ganzen Seitenrande des Sternums und auch am grössten Theile des hinteren oder caudalen Randes des Brustbeines inserirt. Die Brust- und Schultermuskeln werden natürlich von den theilweise aponeurotisch gewordenen, flachen Insertionstheilen des *M. sterno-hyoideus* bedeckt.

"Der Muskel wird durch Zweige des *N. hypoglossus*, und weiter abwärts von den meisten Cervicalnerven aus innervirt.

"Als eine mediane, innere, von dem eben beschriebenen Muskel abgetrennte Masse ist ein Muskel aufzufassen der bei *Apteryx* mit geringer Ausdehnung fleischig vom Coracoid, nahe dessen Verbindung mit dem Sternum entspringt und sich streng median- und kopfwärts gerichtet, etwas oberhalb der Theilung der Trachea in die Bronchien an der Trachea befestigt; von dort begleitet er die Trachea, an derselben seitlich besfestigt, wird im Bereich des oberen Drittels der Luftröhre sehr schwach, schwillt aber nahe dem Thyreoidknorpel wieder an und inserirt sich an dessen Seiten- und Unterfläche. Wir bezeichnen ihn als *M. sterno s. coraco-thyreoideus.* Dieser Muskel wird ausschliesslich durch einen Ast des *N. hypoglossus* innervirt, der bis in die Brust hinabsteigend in dem Muskel verfolgbar ist.

"Andere das Sternum und den Schultergürtel mit der Trachea oder mit dem Zungengerüst verbindende Muskeln besitzt *Apteryx* nicht. Das bei diesen Ratiten bestehende Verhältniss giebt uns Aufschluss über die complicirteren Zustände bei den andern Vögeln. Aus den beiden Muskeln des *Apteryx* sind mehrere entstanden, von denen aber nur die mit dem Zungengerüst in Verbindung stehenden hier besprochen werden, während die übrigen, als in den Dienst der Respiration und Stimmbildung getreten, bei jenen Organen erschöpfend behandelt werden. Ein *M. sterno-hyoideus* findet sich ausser bei *Apteryx* bei manchen Carinaten. Bei Prosthemadera wird er jederseits durch ein schmales Band gebildet, welches im Winkel der Symphyse der Furcula entspringt und direkt, ohne andre Verbindungen einzugehen sich an der Basis des Zungenbeins und zwar mehr an dessen Dorsalseitenrand inserirt; nur wenige Fasern befestigen sich an der Wurzel der Zungenhörner.

"Bei *Meleagris* ist nur die bei *Apteryx* als innere erwähnte mediane

Portion vorhanden. Dieselbe kommt vom Proc. lateralis anterior des Brustbeins, geht zur Seite der Trachea, wird sehr schwach und schwillt am obern Ende wieder an, um sich am Larynx und am Os urohyale zu befestigen; ausserdem aber ist sie nahe dem Larynx an jeden der Trachealringe befestigt, oder eigentlich kommt von diesen Ringen und geht zum Urohyal, den benachbarten Theilen des Basihyal und der Zungenhörner. Als eine deutliche Abspaltung des angen Muskels besitzt *Meleagris* noch einen, der sich vom ventralen und seitlichen Rande des Thyreoidknorpels und vom Seitenrande des ersten Trachealringes selbständig und frei an der Seite des Halses her abzieht, in der Nähe der Schulter aber ventralwärts mit dem der anderen Seite convergirt und eine sehr dünne, ziemlich schlüpfrige Schicht von Bindegewebe ohne Muskelfasern bildet, die sich allmälich an der Ventralfläche des untern Endes der Luftröhre anheftet. Diese beiden langen Muskeln von *Meleagris* werden von einem Zweige den *N. hypoglossus* begleitet.

"Denkt man sich nun, wie das übrigens schon bei *Apteryx* und *Meleagris* angedeutet ist, dass die Fasern des *M. sterno hyoideus* und claviculo-hyoideus im Bereich des mittleren Halsdrittels verkümmern, so zerfallen ebengenannte Muskeln je in einen obern Theil, der dann als *tracheo-hyoideus* und *tracheo-laryngeus* superior und in einen untern Theil, der als *sterno- s. coraco- s. cleido-trachealis* und *tracheo-laryngeus* inferior betrieben werden kann. Jeder derselben kann wieder in Unterabtheilungen zerfallen.

"So haben wir bei *Rhea* folgende Muskeln: 1. Ein *M. tracheo-aryngeus* superior. Derselbe erstreckt sich von der Ventralfläche des Hinterrandes des *Thyreoids* auf die Seitenfläche des obern Drittels der *Trachea.* 2. Sein vorderster Theil ist ein *Thyreo-glossus s. hyoideus*, denn er verbindet die Ventralfläche des *Thyreoids* mit dem Hinterrande des Os basihyale. 3. Von der Seitenmuskulatur der Trachea löst sich ein wohlentwickelter bandartiger Muskel ab, der sich am obern Ende des ersten Gliedes des Zungenbeinhornes befestigt, daher *M. tracheo-hyoideus* zu nennen ist. 4. Die Brustpartie derselben Muskelmasse ist sehr dünn geworden und verliert sich in der Haut des Halses, ohne mehr die Brust zu erreichen. Ausserdem ist 5, ein *Sterno-trachealis* vorhanden und ein daraus differenzirtes Paar Syrinx-Muskeln.

"Bei *Nycticorax griseus* besteht ein dem *M. tracheo hyoideus* und *thyreo-hyoideus* von *Rhea* vergleichbares Muskelpaar, das mit einigen Zügen von der Trachea, hauptsächlich aber vom Thyreoid-Knorpel zum Basihyal geht. Die Luftröhre wird nicht von Mus-

keln begleitet, die betreffenden Theile sind daher ausgefallen, und nur ein *M. sterno-trachealis* nebst einem primitiven Syrinxmuskel oder *M. tracheo-bronchialis* ist vorhanden.

"Bei *Cacatua roseicapillus* kommt ein dünnes Muskelband vom Larynx und vom Zungengerüst; ein Theil begleitet die Luftröhre bis zu den Syrinx- und Tracheo-clavicular-Muskeln und wird wie diese nur vom *N. hypoglossus* innervirt; ein dickerer, mehr seitlicher Theil breitet sich bald auf der Halshaut aus, verwebt sich dort mit den Hautmuskeln und erreicht das Brustbein oder den Schultergürtel nicht. Hauptsächlich von einem langen Zweige des *N. hypoglossus* versorgt, erhält er weiter unten auch Zweige aus den Cervicalnerven.

"Beim Grünspecht (Taf. xxxiii., Fig. 35A) [not here reproduced], kommt jederseits ein dünner Muskel vom Schultergürtel, begleitet die Trachea in ihrer ganzen Länge und stösst erst nahe dem Kehlkopfe mit dem der anderen Seite zusammen, worauf sich beide am Thyreoid und dem medianen Zungengerüst inseriren.—Ein zweiter Muskel kommt von der Clavicula und geht etwas seitlich von dem vorigen gerade kopfwärts als ebenfalls schmales Band und inserirt sich am Thyreoidknorpel und am Grunde des Zungenbeinhornes seiner Seite.

"Ein dem *M. tracheo-hyoideus* entsprechender Muskel erreicht bei den Spechten seine höchste Entwicklung. Er entspringt jederseits von der Trachea unterhalb des Kehlkopfes, windet sich dann mehrere Male (beim Grünspecht viermal) lose um die Luftröhre und geht dann an die Basis des Zungenbeinhornes. Bei weit herausgestreckter Zunge entrollt sich dieser eigenthümliche Müskel seine Funktien ist Zurrückziehen der Zunge.

"Wir können daher diejenigen Zungenmuskeln, welche entweder mit dem Brustbein und Schultergürtel, oder mit der Luftröhre und dem oberen Kehlkopfe zusammenhängen, folgendermassen zusammenfassen.

"I. Gruppe.

"Vom Sternum zum ganzen Zungenhorn, und zum Basihyal: *Sterno-hyoideus; Apteryx.*

"Von der Clavicula hauptsächlich zum Zungenkörper; *Cleido-hyoidei;* Prosthemadera, Ptilotis, Pici.

"Dieselben Muskeln erreichen aber die Brust nicht, sondern sind an der Halshaut befestigt; Papageien.

"II. Gruppe.

"Von der Trachea zum Zungengerüst und zwar zum Cerato-hyal;

Tracheo-hyoidei; Nectarinia; Pici; Grallæ; Rasores; Raptores: Rhea.

"Vom Larynx (Thyreoid) und theilweise auch von der Trachea zum Basihyal, Entoglossum und Urohyal; *Thyreo-hyoidei*; Anser; Gallus: Rasores; Ptilotis; Rhea; Spheniscidæ.

"105. M. GENIO-HYOIDEUS.

M. genio-hyoides. Steno.
Le muscle conique de l'os hyoide. Vicq de Azyr, 1773, p. 535.
Protahens linguæ. Wiedemann, p. 71.
Mm. conici ossis hyoidei. Tiedemann, § 90, No. 3.
,, ,, Kutorga, p. 20.
Tiefer Vorwärtzieher oder Kinnzungenbeinmuskel. Meckel, p. 409, No. 3.
Mylo-cerato-hyoidien. Duvernoy.
Genio-hyoideus. Gurlt, p. 15.
,, Nitzsch, p. 135, No. 3.
,, Gadow, Tenuirostres, *Proc. Zool. Soc.*, 1883, p. 67-
Mylo-ceratoideus anterior et posterior. Nitzsch, in seiner *Tafelerklärung*, p. 151.
Genio-ceratoideus. Huber.
Protracteur de l'hyoide (genio-hyoïdien). Gervais et Alix, p. 18.
Protractor linguæ. Watson, p. 135.

"Dieser Muskel entspringt vom inneren, unteren oder vom oberen Rande des Unterkieferastes, ungefähr in dessen Mitte und geht bandförmig gerade nach hinten, ventral von dem *M. mylo-hyoideus anterior*, aber dorsal oder in der Tiefe von *M. mylo-hyoideus posterior* gelegen, an die vorwärtsschauende Seite der Zungenbeinhörner, um die er sich theilweise herumwindet; ihr Enddrittel ist ganz von den Muskelfasern umgeben. So verhält es sich bei vielen Vögeln, z.B. bei *Corvus, Anser, Procellaria, Spheniscus.* Häufig jedoch (*Nectarinia, Otis*) zerfällt das vom Unterkieferkommende Band in zwei, von denen das eine sich wie gewöhnlich um das Zungenbeinhorn herumwickelt, während das andere sich nur an der äusserten Spitze desselben befestigt, beide Theile sind aber von einer gemeinsamen schlüpfrigen Scheide umgeben, wodurch ihr Zusammenwirken und zwar ausschliesslich in der Richtung des Knochens, gesichert ist. Bei *Prosthemadera* war der Ursprung des Bandes auf die Aussenfläche des Unterkiefers gerückt.

"Bei den Papageien ist der Muskel ganz getheilt. Der vordere (Taf. xxxii., Fig. 30D) [not re-figured here] entspringt vorn an der

inneren Fläche des Unterkiefers und geht zum letzten Drittel des ersten langen Gliedes des Zungenbeinhorns, erstreckt sich auch wohl etwas zum zweiten, umwickelt aber bei Papageien das Zungenbeinhorn nicht so wie bei vielen andern Vögeln. Der hintere Theil (Fig. 30c) [not re-figured here] entspringt weit vom vorderen entfernt am unteren Rande des Unterkieferastes etwa in der Mitte seiner Länge und geht an das sehr kurze zweite Glied des Zungenbeinhornes seiner Seite. Nitzsch schlägt für diese beiden Muskeltheile die Namen *M. mylo-ceratoideus anterior* und *posterior* vor. Bei *Rhea* sind ebenfalls zwei ganz getrennte Bänder vorhanden. Das vordere entspringt aus dem Kinnwinkel und stösst in der Mittellinie mit dem der anderen Seite zusammen; es inserirt sich am Ende des ersten Gleides des Zungenbeinhornes. Das äussere Band ist schmäler und wickelt sich um die äusserste Hälfte des letzten Gliedes des Zungenbeinhornes.

. . . . .

"106. M. GENIO-GLOSSUS.

M. myloglosse. Duvernoy, p. 6, No. 5.
M. genioglossus. Nitzsch.

"Dieses Muskelpaar scheinen nur wenige Vögel zu besitzen. Bei den Papageien entspringt es vorn dicht neben der Mittellinie der inneren Kinnfläche, wird vom *M. mylo-hyoideus* bedeckt und begibt sich als dünnes Band an den Seitenrand des hinteren Endes des Os entoglossum. Nach Nitzsch fehlt es bei vielen anderen Vögeln, oder es ist, wie bei den Raubvögeln, wo es im Frenulum der Zunge vom Rachen aus durchscheint, so schwach, dass es leicht übersehen wird.

"Den Penguinen, Trappen, Gänsen, Krähen, Hühnern, Spechten Kolibris, Nectarinien scheint es in der That zu fehlen.

"Bei *Procellaria* ist der Muskel sehr dünn, liegt der Mundschleimheit an, und erstreckt sich vom seitlichen hinteren Theile des Os entoglossum dünner werdend und mit dem der andern seite convergirend zum Kinn."

. . . . .

"107. M. CERATO-GLOSSUS.

Cérato-glosse. Cuvier.
Cérato-glosse. Duvernoy.
Cerato-glossus. Tiedemann, § 91, No. 1.
,, Kutorga, p. 21.

Cerato-glossus. Watson, p. 134.
„ Gadow, p. 67.
Nieder- und Seitwärtszieher der Zunge. Meckel, p. 408, No. 1.
Ceratoglossus inferior s. basioglossus lateralis und superior. Nitzsch, p. 136, 137.
Basioglossi inferiores et superiores. Kutorga, p. 21.
L'hyo-glosse. Gervais et Alix, p. 18.
Grund-Zungenmuskel (*basio-glossus*). Gurlt, p. 15.
Griffel- oder Zungenbein-Zungenmuskel (*stylo-hyoideus*). Gurlt, p. 15.

"Im allgemeinen entspringt dieser stets vorhandene Muskel fleischig von der oberen Fläche des ersten Abschnittes des Zungenbeinhornes und inserirt sich mit einer langen, deutlichen Sehne am Seitenrande des Os entoglossum. Häufig zerfällt er in zwei Theile; der eine kürzere geht bei den Hühnern vom Zungenkörper (Os entoglossum) bis fast zur Spitze der Zunge, die er herabkrümmt, er liegt dann auf der Ventralseite der Zunge; der andere längere kommt vom Zungenbeinhorn und endigt sehnig am Grunde des Körpers." [This account of the *cerato-glossus* (the *cerato-glossal* as described by me above for the Raven) is completed by Gadow by a few words upon its variations as found by him in a number of groups of birds.]

. . . .

"108. M. CERATO-HYOIDEUS.

Cérato-hyoïdien. Cuvier.
Cerato-hyoideus. Tiedemann, § 90, No. 4.
„ Kutorga, p. 21.
„ Meckel, p. 409, No. 4.
„ Nitzsch; Gurlt, p. 14.
„ Duvernoy.
Cératoidien transverse. Gervais et Alix, p. 19.
Cerato-transverse muscle. Watson, p. 134.

"Ein kurzer Muskel, der fleischig von der Innenseite des ersten Stückes des Zungenhornes entspringt und mit schräg vorwärts und median gerichtetem Verlauf an den unpaarigen Stiel des Zungengerüstes (Os urohyale) inserirt, häufig verbinden sich dabei die gegenseitigen Muskelzüge.

"Verwebung mit dem ventral gelegenen *M. mylo-hyoïdeus posterior* ist gewöhnlich.—Fehlt aus Os urohyale, wie bei *Rhea* und bei *Platalea*, so ist auch der Muskel nicht vorhanden, letzteres gilt aber

auch bei vielen Vögeln, welche wie der Flamingo, Storch, manche Raubvögel, Prosthemadera, Nectarinia den unpaarigen Stiel besitzen.

"Bei *Eudyptes chrysocome* ist der Muskel recht lang; er kommt vom zweiten Drittel des Zungenbeinhornes und verbindet sich auf dem Urohyal mit dem *mylo-hyoideus.* Er scheint eine den Vögeln eigenthüm-Differenzirung des *M. cerato-glossus* zu sein.

"109. M. HYPOGLOSSUS.

"Jederseits aus einem oder zwei Muskelchen bestehend, die von der Unterfläche des Os basihyale entspringen und neben einander auf der Unter- und Seitenfläche des Os entoglossum sich inseriren. Sie werden durch einen Zweig des Ramus lingualis *N. hypoglossi* innervirt und sind höchstwahrscheinlich als tiefere, etwas selbständig gewordene Theile des *M. ceratoglossus* aufzufassen.

"*a.* M. HYPOGLOSSUS OBLIQUUS.

Hyoglosse transverse. Cuvier; Duvernoy.
Hyoglossus obliquus s. parvus. Tiedemann, § 91, No. 2.
,, ,, ,, Gurlt, p. 15.
Heber der Zunge. Meckel, p. 408, No. 2.
Hypoglossus obliquus. Nitzsch.
Hyoïdien transverse. Gervais et Alix, p. 18.
Transverse hyoid muscle. Watson, p. 136.

"Jederseits ein kleiner Muskel, der vom Ceratoglossus bedeckt wird; sie entspringen nebeneinander von der unteren Fläche des Zungenbeinkörpers (Basi-hyal) mit schiefen Fasern, schlagen sich um dessen Seitenrand und setzen sich an den hinteren Seitenrand des dem Basi-hyal aufsitzenden Os entoglossum oder Zungenkern. Bei *Procellaria* und *Spheniscidæ* sind die beiden Muskelchen ziemlich transversal gerichtet, mehr länglich dagegen bei den Papageien (Taf. xxxi., Fig. 36 und xxxii., Fig. 34) [figures not reproduced here]. Bei *Rhea* sind diese Muskeln mit dem sie ganz bedeckenden *M. cerato-glossus* verwachsen. Bei Passerinen habe ich sie nicht bemerkt; bei *Pelecanus* und *Sula,* die eine sehr verkümmerte Zunge haben, scheinen sie ganz zu fehlen.

. . . . .

"*b.* M. HYPOGLOSSUS RECTUS.

Hyoglosse droit. Cuvier; Duvernoy.
Hyoglossi interior s. rectus. Tiedemann, § 91, No. 3.
Musculi linguales inferiores. Kutorga, p. 21.

Zungenbeuger. Meckel, p. 408, No. 3.
Hypoglossus rectus. Nitzsch.

"Liegt wie der *M. hypoglossus obliquus* an der unteren Fläche der Zunge. Er entspringt nahe der Mittellinie etwas vorwärts vom *M. H. obliquus* und inserirt sich nahe dem Vorderende des Os entoglossum.

"Am deutlichsten entwickelt bei Papageien, fehlt er sehr vielen Vögeln, und ist überhaupt nichts weiter als die vordere Verlängerung des *M. hypoglossus obliquus.* Hiermit stimmt seine Innervation überein."

NOTE.—These are all the lingual muscles alluded to by Professor Gadow in Bronn's *Thier-Reichs,* and a moment's comparison will show the corresponding ones as I found them in *Corvus,* and also such as are not found among Passerine birds. The following seem to be the correspondences to which I allude :—

SHUFELDT.		GADOW.
Mylo-hyoideus	=	M. mylo-hyoideus anterior.
Stylo-hyoideus	=	M. mylo-hyoideus posterior.
Genio-hyoideus	=	M. genio-hyoideus.
Cerato-hyoideus	=	M. cerato-hyoideus.
Sterno-hyoideus	=	M. sterno-hyoideus.
Depressor-glossus	=	M. hypoglossus obliquus (?).
Cerato-glossus	=	M. cerato-glossus.

What I take to be the *M. hypoglossus obliquus* of Gadow appears to be sufficiently evident in *Corvus,* and further than that genus I have not as yet looked into the matter.

IV. THE MUSCLES OF THE AIR PASSAGES.

As in the vast majority of birds, the rings and half-rings of the trachea of the Raven are completely ossified in the adult individual. This applies also, with equal truth, to the several parts of the superior larynx. These cricoid bones and the pair of arytenoid bones are so well known as to require no special description from me here. Their arrangement is very well shown in Fig. 10, where they are represented, *in situ*, double the size of life.

Anteriorly, the upper larynx is composed of one shield-shaped osseous plate, the thyroid, which rests upon the upper side of the second basibranchial, in the fork of the greater cornua of the hyoid.

This plate is also seen in Figs. 9 and 10.

The bronchial half-rings, and those of the lower larynx, likewise ossify, but not quite so completely as do the tracheal rings above them.

In the Raven we have devoted to the superior larynx two muscles—

28. The constrictor-glottidis.
29. The thyreo-arytenoideus.

And to the lower larynx seven more, viz.—

30. The tracheo-lateralis.
31. The broncho-trachealis posticus.
32. The broncho-trachealis anticus.
33. The broncho-trachealis brevis.
34. The bronchialis posticus.
35. The bronchialis anticus.
36. The sterno-trachealis

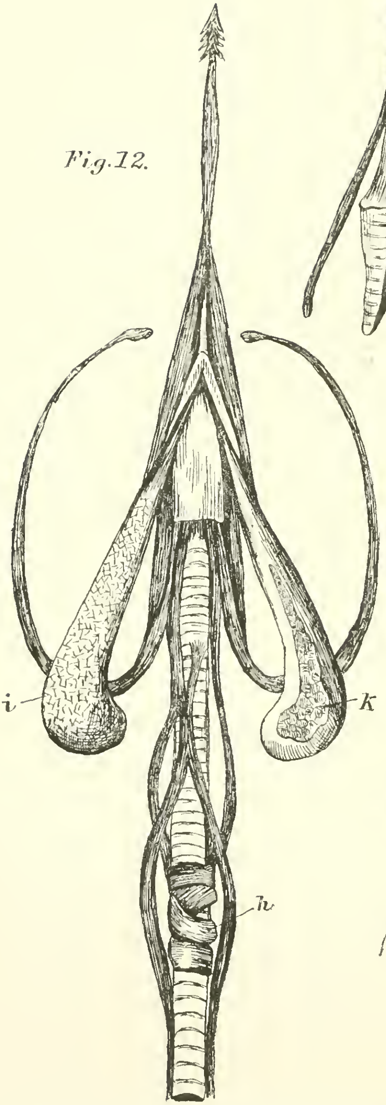

Fig. 12.

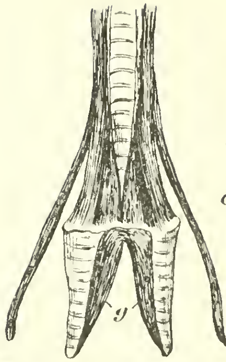

Fig. 13.

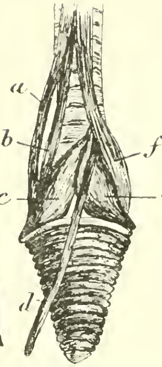

Fig. 14.

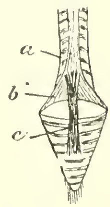

Fig. 15.

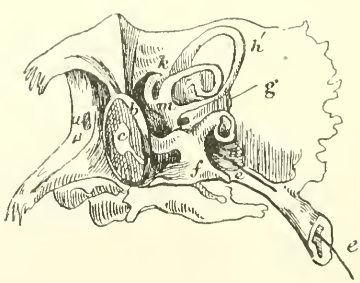

Fig. 16.

Fig. 12.—Tongue and salivary glands, Woodpecker. *i* and *k*, the glands, the latter opened to show internal structure ; *h*, the four turns of the *cerato-trachealcs* around the trachea. (After Owen.)

Fig. 13.—Front view of the lower larynx and bronchi of a Raven. *g*, part of the peripheral surface of the tympaniform membrane. The muscles above are named in Fig. 14. (After Owen.)

Fig. 14.—Side view of the same parts that are shown in Fig. 13. *a* and *f*, diverging fasciculi of the *tracheo-lateralis* muscle ; the fasciculus *a* is

the *broncho-trachealis posticus*, and the fasciculus *f* is the *broncho-trachealis anticus* muscle ; *b* is a separate muscle, the *broncho-trachealis brevis ; c*, the *bronchialis posticus ; e*, the *bronchialis anticus ; d*, the *sterno-trachealis*. (After Owen.)

FIG. 15.—Lower larynx of a Parrot. *a, tensor longus glottidis* muscle. *b, tensor brevis glottidis ; c*, a narrow muscle passing from the tracheal to the bronchial half-rings. (After Owen.)

FIG. 16.—Organ of hearing, Owl. *f*, the *tensor tympani* muscle ; *e*, the Eustachian tube ; *h'*, the superior semicircular canal ; *c*, tympanum, and *b* is its periphery. (After Owen.)

28. *The constrictor glottidis.*—The inner margins of the *rima glottidis* in the Raven are formed by the mesial borders of the arytenoid bones. These latter articulate posteriorly with the middle segment of the cricoid, their anterior ends being free. Now the constrictor glottidis muscle arises, on either side, from the superior and longitudinal line of the thyroid plate. From this origin it sweeps outwards, then upwards, and finally inwards in a gentle curve, to be inserted all along the inner margin of the corresponding arytenoid bone, and to the apex of the mid-cricoidal segment.

When this pair of muscles firmly contract together, they efficiently close the *rima*, and draw the apices of the arytenoids to the middle line, and close against the upper surface of the thyroid plate. This action of the constrictor glottidis is opposed by the next muscle, the opener of the *rima*.

29. *The thyreo-arytenoideus* (Figs. 10 and 18).—This pair of muscles arise, one on either side, from the entire outer margin of the thyroid plate, and the corresponding margin of the outer cricoid bone (Fig. 10).

The fibres pass inwards, directly across the opening of the windpipe, to be inserted all along the outer margin of the arytenoid bone of the same side, and the corresponding border of the central cricoid piece. It is evident that the contraction of this pair will tend to pull the arytenoid bones outwards, and thus open the *rima glottidis*.

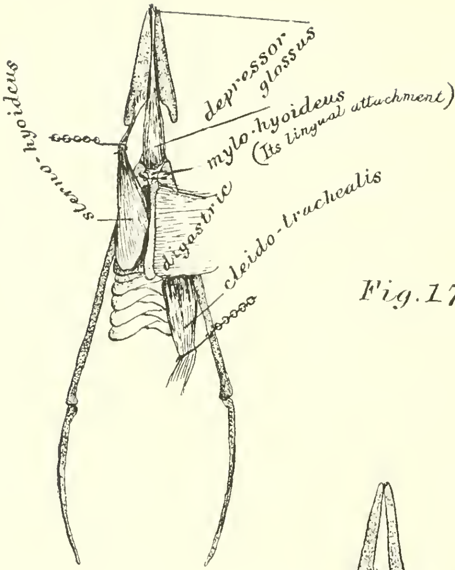

Fig. 17.

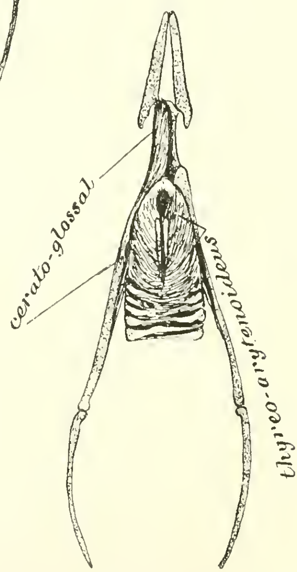

Fig. 18.

FIG. 17.—The under side of the hyoid arches of a Raven, with the superior larynx and upper part of the windpipe, *in situ*. Designed to show the attachment of the muscles of the parts; the *sterno-hyoideus* and the *cleido-trachealis* are pulled outwards by dissecting hooks. Life-size, by the author from his own dissections.

FIG. 18.—Superior view of the same parts, with lower muscles removed, but showing those attached to the upper side of the hyoid and superior larynx. The *rima glottidis* is represented as closed, with the arytenoids in contact. The elliptical aperture, which always remains in front, is closed by the upper surface of the thyroid plate beneath it.

"From the simplicity of the structure just described, from the situation of the superior larynx with relation to the rictus or gape of the bill, and from the absence of lips by which this might be partially or entirely closed, it is plain that it cannot be considered as influencing the voice, otherwise than by dividing or articulating the notes after they are formed by the lower larynx. The superior larynx presents, indeed, but few varieties in the different species of Birds; and these relate chiefly to certain tubercles in its anterior, which vary in number, and do not exist at all in some species, as the Singing Birds; being chiefly present in those birds which have a rough, unmusical voice. In the Pelican, the Gigantic Crane, and most of the *Rasores*, a process extends backward in the cavity of the upper larynx from the middle of the posterior surface of the thyroid cartilage, and seems destined to give additional protection to the air-passages" (Owen).

To examine the lower larynx, we must carefully free the trachea from the strong connective-tissue which surrounds it between the limbs of the furcula; then cut through the clavicular arch close to the hypocleidium, through the pectoral muscles, and down through the sternal body close to the carina. By means of this incision carefully open the chest. Next, after studying the relations of the beautiful pair of sterno-trachealis muscles, nip off the costal processes of the sternum, and free them from attached structures. Cut through the bronchi close to the lung, on either side, then lift out the lower larynx for examination.

30. *The tracheo-lateralis*—or either one of a pair of muscles of that name, for all seven muscles of the lower larynx of a Raven are in pairs—is formed by the union of the broncho-trachealis anticus and the broncho-trachealis posticus, about one and a half centimetres

above the bifurcation of the bronchi, on the lateral aspect of the trachea. It ascends the side of the trachea for its entire length, as a narrow ribbon of muscle closely attached to the rings, until it arrives near the superior larynx, when it spreads out like a fan, and its faint and delicate fibres attach themselves to the side of the upper end of the windpipe. Contraction of this pair of muscles must shorten the trachea by closely approximating the upper and lower borders of its rings. It also gives some support to this tube by acting as a brace to its sides.

31. *The broncho-trachealis posticus* is the hinder fasciculus formed by the forking of the last-named muscle. Its fibres pass downwards and backwards, and are inserted into the end of the third half-ring of the same side.

32. *The broncho-trachealis anticus* is the remaining limb of the bifurcation of the lower extremity of the tracheo-lateralis. Its fibres descend downwards and forwards to insert themselves upon the *anterior* extremity of the third half-ring of the corresponding side (Fig. 19).

33. *The broncho-trachealis brevis* is, upon either side, a strong, straight, subcylindrical bundle of muscular fibres which arise above just beneath the broncho-trachealis anticus muscle, descend rather obliquely across the larynx, to become inserted into the hinder end of the second bronchial half-ring (Fig. 14, *b*). This muscular slip, as is shown in Fig. 19, is considerably larger than the broncho-trachealis posticus, which passes down, for the major part of its descent, alongside of it.

34. *The bronchialis posticus* is a chunky little spindle-formed muscle, situated below the other muscles just described. It arises by its superior apex from the latero-inferior margin of the ultimate tracheal ring,

while its lower apex is inserted into the posterior extremity of the second half-ring. To do this it must be evident that it lies obliquely across the larynx.

35. *The bronchialis anticus* has much the same form as the last muscle, but is fully double its size. It is crossed at its origin by the broncho-trachealis anticus, which must be pulled to one side in order to examine it. We find that its superior apex arises from the last ring of the trachea, from which point the fibres pass obliquely forwards to become inserted by a lower apex into the rim of the arytenoid cartilage of the lower larynx, and the anterior extremities of the first and second half-rings.

36. Either *sterno-trachealis* is represented by a delicate little cord of muscular fibres, which arise on the side of the trachea beneath the hinder border of the broncho-trachealis anticus, and pass directly outwards, a little downwards and backwards, across the cavity of the chest, to become inserted on the inner aspect of the corresponding costal process of the sternum, rather in advance of its centre. A delicate band of fascia spans the insertion of this muscle a few millimetres in front of its point of attachment. This is shown in Fig. 19. According to Owen, " this is the most constant of all the muscles affecting the lower larynx. It is reckoned by Savart as the sixth pair of vocal muscles, but not by Cuvier, since it is not directly attached to any part of the lower larynx, and exists in birds, as, *e.g.*, the Vulture and Ostrich, in which that larynx is not developed " (*Anat. Verts.*, vol. ii. p. 224).

The infinite number of changes that the foregoing muscles can bring about in the form of an organ so constituted as the inferior larynx of the Raven is, can be more easily imagined than described. The principal

fact, however, to be kept before us is, that as the form and tension of its walls vary, the tympanic membrane

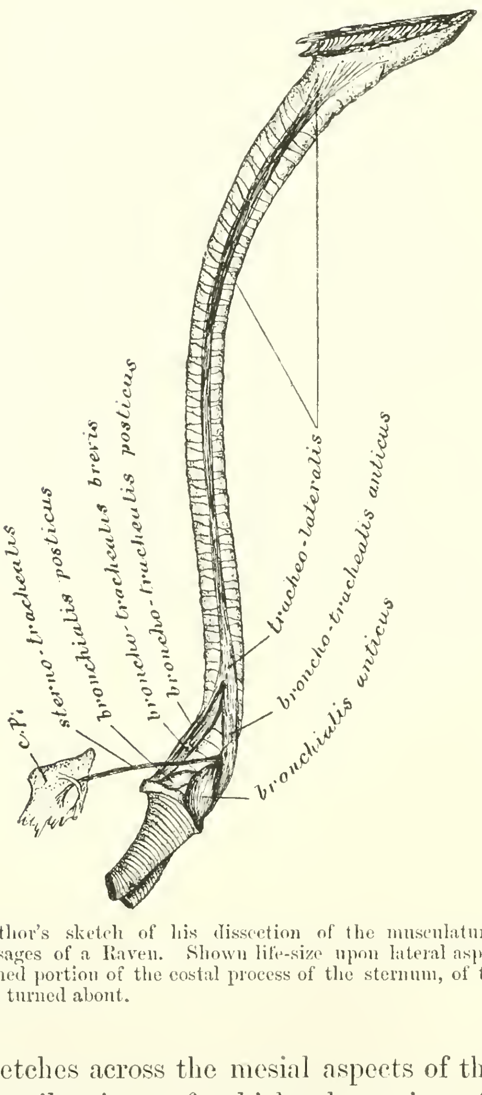

FIG. 19.—Author's sketch of his dissection of the musculature of the air passages of a Raven. Shown life-size upon lateral aspect. *c.p.*, detached portion of the costal process of the sternum, of the right side, and turned about.

which stretches across the mesial aspects of the bronchi, upon the vibrations of which the voice of the bird

depends, must also be brought to different degrees of tension in its different parts. Striking from the list the sterno-tracheales, all the muscles we have enumerated for the true larynx are *tensors*, as it is evident their contraction must stretch the tympanic membrane by lengthening the bronchi to which, as we have just said, it is attached. On the other hand, if the sterno-tracheales contract, they must stretch the windpipe, and thus shorten the bronchi, and relax the tympanic membrane. A glance at Fig. 13, where *g* is the tympanic membrane, will at once make these points clear.

Professor Owen found that "in many of the Volitores there is a single pair of 'broncho-tracheales,' and a single pair of short ventricose 'bronchiales.' In *Thamnophilus* each sterno-trachealis bifurcates to send a small strip to the lower larynx, and the rest to the side of the trachea, as usual. In *Furnaria* the sterno-trachealis is inserted into the upper end of a long appendage to the upper bronchial half-ring.

"The Parrot tribe have a single glottis bounded by a lateral pair of vibratile membranes; each membrane connecting together, and occupying the interspace between, the last tracheal and first bronchial rings. These have each one margin concave, with the concavity towards each other, and are movably joined together at their fore and hind extremities. These half-rings expand, and stand out from the end of the trachea. A narrow muscle, 'tensor longus glottidis,' Fig. 105 [14], *a*, passes from the side of the trachea to the upper (tracheal) half-ring; and, by raising it, makes tense the elliptical elastic membrane: a broader 'tensor brevis glottidis,' *ib.*, *b*, passes from the lower rings of the trachea to the same half-ring, diverging to its extremities; a third narrow muscle passes from the tracheal to the bronchial half-

rings, *ib.*, *c*, and by approximating them, relaxes the membrane occupying the elliptical interspace. These membranes, projecting on each side into or below the termination of the air-tube, leave a narrow chink between them, through which the air passes to and from the lungs; and when, in forcible expiration, the membranes are put into a sufficient state of tension, they vibrate, and the vocal air is driven along the trachea through the upper larynx, where some modification of sound may be made. The tongue of the Parrot is more fleshy than in most birds. These structures, concomitant with the single glottis and pair of vocal folds in the lower or true larynx, relate to the faculty, so remarkable in these singular birds, of imitating human speech."

Other interesting variations in these structures are to be found in certain Cranes, in the peculiar Snipe *Rhynchæa*, in certain Gallinaceous birds, and still more especially in many of the Anserine fowl.

V. THE MUSCLES OF THE EYE AND EAR.

UNDER this head we will notice the following :—

Those of the eye—

37. Orbicularis palpebrarum.
38. Levator palpebræ superioris.
39. Depressor palpebræ inferioris.
40. Quadratus nictitantis.
41. Pyramidalis nictitantis.
42. Obliquus superior.
43. Obliquus inferior.
44. Rectus superior.
45. Rectus inferior.
46. Rectus externus.
47. Rectus internus.

And the single one I propose to describe for the ear—the

48. Tensor tympani.

To commence the dissection for a study of the muscles of the eye in the Raven, we should divide the skin down to the bone by a circular incision passing completely around it, a good distance back from the margins of the lids. Then dissect carefully, reflecting the integument as we approach these latter, equally all about them. This is best done by holding its free edge with the thumb and finger of the left hand, while we dexterously use a sharp scalpel held in the right, the skin being kept on the stretch.

37. *The orbicularis palpebrarum* is the first muscle we shall reveal during such a dissection, and its principal

origin seems to be upon the lacrymal and maxillary bones (Fig. 22, *o.p.*). Superiorly the circumscribing

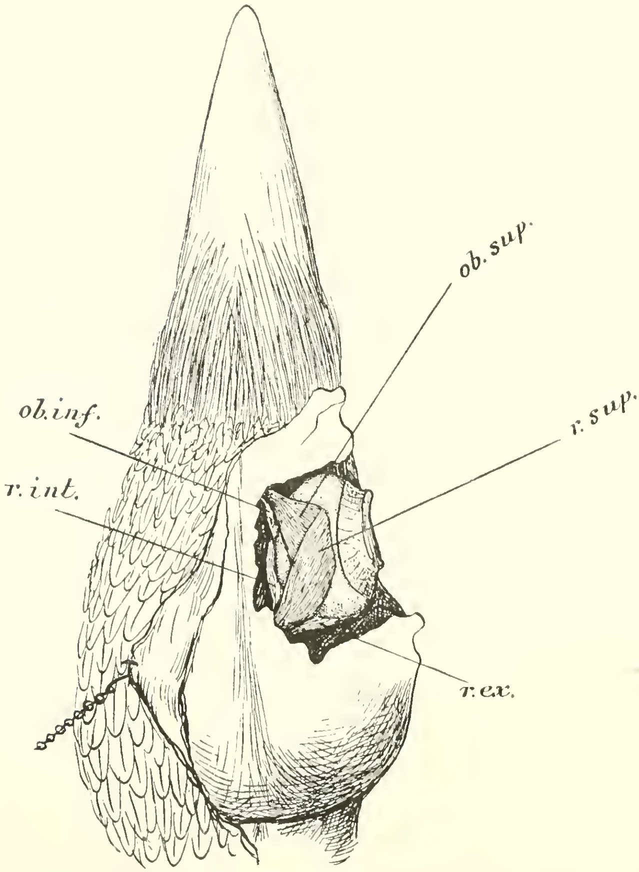

FIG. 20.—Superior aspect of head of Raven, with skin on right side dissected away, and the roof of the orbit removed, to show muscles of eye within. Life-size, by the author from his own dissections. *ob. inf.*, obliquus inferior; *ob. sup.*, obliquus superior; *r. int.*, rectus internus; *r. ex.*, rectus externus; *r. sup.*, rectus superior.

fibres become very indistinct, in which locality they are inserted directly into the ciliary margin. Below, they are attached to the lower free edge of the tarsal cartilage,

and it is upon this lid that the action of the muscle is principally exerted, the eye being covered and closed, by its being drawn upwards over it.

This muscle may now be divided at its principal origin; the integument dissected quite up to the free edges of the lids, where we carefully divide it all around, in order to remove these now unnecessary parts. Reflecting the dense tissue above the eye, we behold the organ *in situ*.

38. *Levator palpebræ superioris.*—The lower eyelid

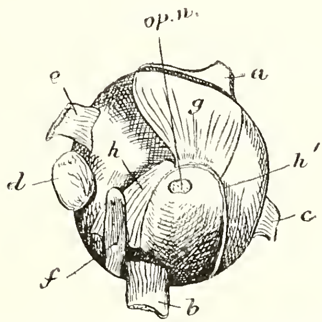

Fig. 21.—Mesial aspect of eye of Goose, to show muscular insertions (after Owen), with certain parts removed that appear in the original. *op. n.*, stump of optic nerve: *e*, obliquus superior; *d*, rectus internus; *f*, obliquus inferior; *b*, rectus inferior; *c*, rectus externus; *h*, pyramidalis; *h'*, its tendon; *q*, quadratus; *a*, rectus superior.

is the one which principally closes the eye in the Raven, consequently we find the present muscle but feebly developed, while, on the other hand, the next to be described is quite strongly so. The levator palpebræ superioris arises along a longitudinal line found at about the middle of the roof of the orbit within. The faint and delicate fibres pass directly outwards to find insertion in the ciliary margin of the upper lid, being best seen rather on the side towards the outer canthus. As in the

Mammalia, the function of this muscle is to raise the superior eye-lid.

39. *The depressor palpebræ inferioris*, as has already been stated, is easily found. Its fibres are attached along the lower margin of the interorbital vacuity. From this line (Fig. 22) they pass outwards beneath the eyeball, to become inserted into the lower lid, where they

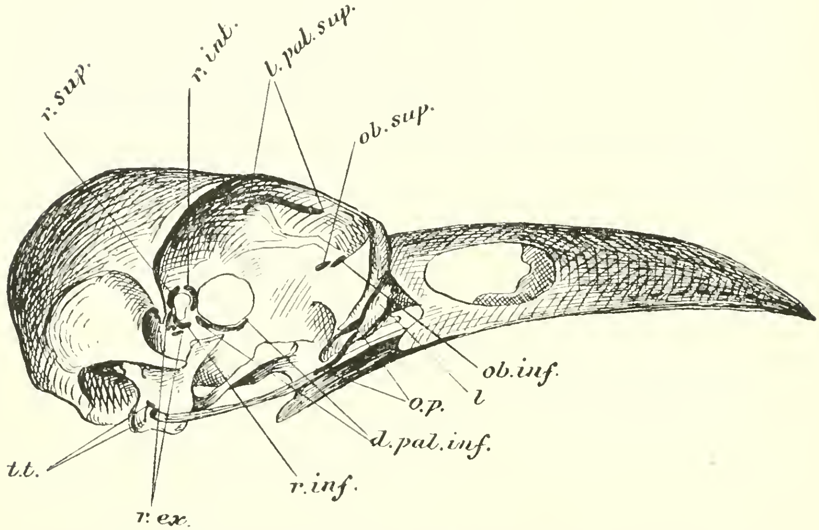

FIG. 22.—Right lateral aspect of skull of Raven, to show exact origins of the principal muscles of the eye, and the tensor tympani. Life-size, by the author. Lettering as in Fig. 20, with *t.t.*, tensor tympani; *o.p.*, orbicularis palpebrarum; *l*, lacrymal bone; *l. pal. sup.*, levator pal pebræ superioris; *d. pal. inf.*, depressor palpebræ inferioris; *r. inf.*, rectus inferior.

antagonize to a certain extent the orbicularis palpebrarum, as by their contraction this integumental veil to the organ of sight, the lower lid, is withdrawn. Owen tells us that this muscle is also found in the Crocodile, and I dare say in other Sauropsida. In the Raven it is the only lid of the three which is reinforced by a

cartilaginous plate, here found between the conjunctival membrane and the ligamentous layer. It is of interest to know that in the *Strigidæ* and *Caprimulgi* the eyes are closed principally through the depression of the upper lids.

In common with most other birds, the Raven possesses a well-developed *membrana nictitans*, which is here of a pearly white colour, and consequently opaque. As it closes, it passes obliquely across the eyeball, from its resting-place in the supero-internal corner, to the one opposite, a movement effected by two special muscles, the next to be described (Fig. 21).

40. *The quadratus nictitantis* finds its origin upon the sclerotic at the upper part of the ball, behind. From this point the fibres converge as they pass towards the optic nerve, and are inserted in an aponeurosis which sheathes the latter above. It is evident that in this course the fibres of the quadratus pass downwards, inwards, and backwards, interfering in no way with the action of the other muscles, have no fixed bony insertion, and do not stand in the way of the passage of the rays of light.

41. *The pyramidalis nictitantis*, the remaining muscle acting upon the membrana nictitans, occurs in the Raven precisely as we find it in the Goose, and it has been so well described by Owen for that bird, that I quote his words. He says the "*pyramidalis nictitantis* (Fig. 21, *h*, of the present work) arises from the lower and nasal side of the eyeball : its fibres converge towards the upper part of the optic nerve, and terminate in a small round tendon which glides through the pulley at the free margin of the *quadratus*; thus, winding over the nerve, it passes down to be inserted into the lower part of the margin of the third eyelid. By the simultaneous action of the two muscles, that nictitating lid is drawn outward and

obliquely downward over the fore-part of the eyeball The tendon of the pyramidalis gains the due direction for that action by winding round the optic nerve, and it is restrained from pressing upon the nerve by the counteracting force of the *quadratus*, which thus augments the power of the antagonist muscle, while it obviates any inconvenience from pressure on the optic nerve, which its peculiar disposition in relation to that part would otherwise occasion. The nictitating membrane returns on the relaxation of its muscles, by virtue of its own elasticity, to the inner corner of the orbit, where it lies folded when not in use" (*Anat. of Verts.*, vol. ii. p. 143).

42. *Obliquus superior.*—As in the Mammalia, the movements of the eyeball depend upon the action of two oblique muscles and four recti muscles (Fig. 22).

The oblique muscles arise close together at the inner and superior angle of the pars plana, their exact origins being shown in the figure. Between them passes the olfactory nerve. The origin of the superior oblique is situated the more posteriorly, and rather lower than that of the obliquus inferior. Its diverging fibres pass backwards and outwards, forming a pretty, fan-shaped little muscle, to spread over the upper side of the eyeball, their extremities being overlapped by the rectus superior. In none of these eye-muscles proper do the terminations of the fibres of insertion reach so far as the osseous circlet formed of the sclerotal plates; and it is evident, further, that, owing to the greatly confined condition of the eyeball, the necessity for a ligamentous pulley to assist the action of the present muscle is obviated.

43. *The obliquus inferior* muscle arises, as we have just stated, close to the last described one (Figs. 20, 22,

ob. inf.). Its fibres pass in exactly the same direction, differing only in their downward, rather than the upward inclination, in order to become inserted in the sclerotic of the inferior aspect of the eyeball, where they are overlapped by the inferior rectus muscle.

The action of these two oblique muscles is too simple to require a detailed description here. They are the direct antagonists to each other, and are principally concerned in movements of torsion of the eye.

44. *Rectus superior.*—The several origins of the recti muscles circumscribe the optic foramen, just within its free border. The rectus superior and internus surround its upper half, while the rectus inferior and externus arise below. The rectus externus arises by two distinct heads, between which the sixth nerve passes out of the brain-case through a small circular foramen which appears to be constant in the Raven (Fig. 22).

The fibres of the rectus superior diverge as they pass forwards, upwards, and outwards, the innermost ones overlapping those of the obliquus superior at right angles. They are inserted into the sclerotic just within the margin of the bony circle of the eye (Fig. 20).

45. *The rectus inferior* muscle is to the rectus superior exactly what the obliquus inferior muscle is to the obliquus superior. Its fibres spreading out like a fan, as they pass from their origin, are inserted on the lower aspect of the eyeball, in the same manner as the fibres of the rectus superior are inserted upon its upper side.

46. *The rectus externus* seems to be the shortest of all the recti muscles; and, as I have already remarked, it arises by two heads, disposed as shown in Fig. 22. It also is fan-shaped, and finds insertion, in a way similar to the two foregoing muscles, on the external, or what is really the posterior side, of a Raven's eye.

47. *The rectus internus*, after leaving its origin, spreads out over the mesial aspect of the eyeball, clearing by a well-devised arrangement the quadratus and pyramidalis, though in intimate relation with the former: it is finally inserted, in a manner common with the others of the group, upon the sclerotic, or the anterior aspect of the

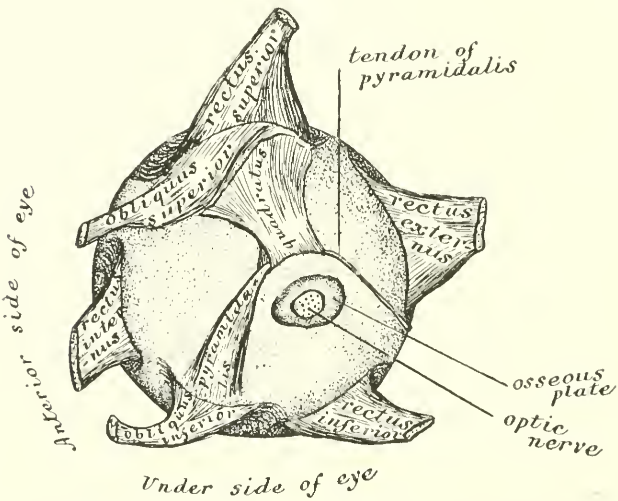

FIG. 23.—The back of the right eye of a Raven, × $2\frac{3}{4}$, and showing the cut stumps of the *recti* and *obliqui* muscles, which, however, are drawn away from the centre to show their proper insertions. The *quadratus nictitantis* is represented in a state of semi-contraction, when it lifts the tendon of the *pyramidalis nictitantis* off of the optic nerve. Could the front of this eye now be seen, the *membrana nictitans* would be found about three-quarters drawn obliquely across the eye. The *pyramidalis* is here contracting then, and it is evident that both its force and function are augmented by this action of the *quadratus*.

The curious elliptical osseous plate surrounding the optic nerve, is also shown in the figure, and I have found it in every Raven's eye that I have dissected.

eye, or what would be the internal side in the Mammalia. Were it to act alone, the other muscles remaining passive, it would so pull the eyeball as to direct the line of vision to the front.

By way of recapitulation, then, of the nomenclature of

the eye and its appendages in a Raven, we find that its movements are effected by *eleven* muscles. The *orbicularis palpebrarum* by its contraction closes the integumental lids. It is antagonized by a feeble *levator palpebræ superioris* in the upper lid, and a much better developed *depressor palpebræ inferioris* in the lower lid, which latter is the one which really "closes the eye."

The third eyelid, or *membrana nictitans* (*nictito*, I wink), is governed in its action by the two muscles, the *quadratus* and the *pyramidalis*, but their operation is best seen by a study of Fig. 23. When these muscles cease to act, the nictitating membrane contracts by virtue of its own elasticity, and again becomes hidden within the recess of the inner canthus, above the commissural point, of the true lids.

The remaining six muscles are devoted to the movements of the eyeball itself. Any of the recti, when acting, antagonize the muscle inserted diametrically opposite it; the two obliques similarly oppose each other, and through the varied traction of the group the line of vision is directed to meet the will of the bird. Owing to the close contact of the bony walls of its chamber, the greater simplicity of the *obliqui*, and, finally, the shortness of all these muscles, the mechanism involving the movements of the eyeball is not nearly so complicated a one in the bird, as we find it to be in any Mammalian form.

VI. THE MUSCULATURE OF THE EAR.

UPON one of the foregoing pages I have already described the *circumconcha* muscle, which I believe, from my dissections, to be a constant one in the Raven. By its contraction it evidently acts as a "laxator" to the tympanum. Careful search in a large number of ears of this bird, however, fails to reveal to me any such "tensor" as described by Professor Owen. I do find, though, the following muscle :—

48. *Tensor tympani.*—If we carefully dissect the integument about the aural orifice in an old bird of this species, we find a small fasciculus of muscular fibres that arise from the inner end of the quadrato-jugal bone, and the contiguous surface of the quadrate. These pass beneath the integumental duplicature in the shallow meatus, to be lost upon the inner surface of the tympanum. Now, as the drum is braced in the ear-passage by at least two or three ligamentous bonds, more especially by a strong one above, it is very evident that, by the contraction of such a muscle as I here describe, the ear-drum would be put upon the stretch, and its tense condition duly effected (Fig. 22, *t.t.*).

In describing the *tensor tympani* in an Owl (Fig. 16, *f.*), Professor Owen says : " It arises from a depression

in the basisphenoid, enters the tympanic cavity above the beginning of the Eustachian tube, and, by its insertion into and action upon the malleus, tends to push the membrane outward; it is counteracted by two small cords extended to the inner walls of the tympanum: but the muscular character of them is doubtful, and the ear-drum resumes its normal state when the tensor ceases to act" (*Anat. of Verts.*, vol. ii. p. 135).

Further investigations in this direction will be very interesting and quite important. The general text-books of Claus, Gegenbaur, Jeffrey Bell, Huxley, and many others at my command, are silent upon this point.[1]

[1] Since writing the above I find the following from Professor Hans Gadow (*loc. cit.*, Bronn's *Klassen*, vi. Band, pp. 442–445) upon the musculature of the eyes and the eyelids in Aves:—

"Die Augenmuskeln (Taf. xliii. and iv.).

[Figures not reproduced here.]

"Die 8 Muskeln des Augapfels und des dritten Augenlides entwickeln sich embryologisch aus den Resten der vorderen Kopfsomiten (vgl. s. 297).

"Der Augapfel selbst wird von sechs Muskeln bewegt, nämlich von vier 'geraden' und zwei 'schiefen' Muskeln.

"1. *M. rectus superior s. attollens* entspringt fleischig von dem oberen Rande des Foramen opticum und heftet sich mit breiter, aber kurzer Aponeurose an den oberen Rand des Uebergangstheiles des Augapfels. Ueber den Urspringstheil des Muskels läuft der R.I. des *N. trigeminus* und der *N. trochlearis.* Innervation durch den *N. oculomotorius* und zwar durch einen kurzen Ast desselben, der sogleich noch seinem Eintritt in die Orbita zur unteren Fläche des Muskels geht.

"2. *M. rectus inferior s. deprimens,* entspringt fleischig von der unteren und hinteren Umgebung des Foramen opticum und inserirt sich mit ziemlich breiter Ausdehnung an dem unteren Rande des Augapfels. Er wird ebenfalls vom *N. oculomotorius* innervirt, und zwar durch ein Büschel feiner Aeste, die den Hauptstamm nach Abgabe des Ramus ciliaris verlassen.

"3. *M. rectus internus s. medialis adduceus*, entspringt nach vorn vom Austritt des Sehnerven und inserirt sich am Innenrande des Augapfels. Er wird medianwärts von der Harder'schen Drüse und vom R. I. *N. trigemini*, nach oben hin vom *M. obliquus* superior bedeckt. Innervirt durch einen Zweig des *N. oculomotorius*.

"4. *M. rectus externus s. lateralis s. abducens*, entspringt seitlich und hinten neben dem *M. rectus superior* und inserirt sich am hinteren Seitenrande des Augapfels. Seitlich von ihm verläuft der R. II. *trigemini*. Innervirt durch einen Ast des *N. abducens*.

"5. *M. obliquus superior*, entspringtweit nach vorn, von der Ethmoidalwand ; über seinen Ursprung zieht der *N. olfactorius* hin, dicht unter ihn verläuft der R. I. trigemini. Der Muskel läuft dann quer über den Insertionstheil des *M. rectus internus* und heftet sich sehr breit dicht nach innen, und theilweise unter der Insertion des *M. rectus superior* an den Augapfel. Er wird vom *N. trochlearis* innervirt.

"6. *M. obliquus inferior*, ein langer dünner, bandartiger Muskel, der seitlich vom *M. rectus inferior* entspringt und sich medianwärts neben demselben inserirt. Nach unten und aussen läuft über seinem Ursprungstheil der R. superior des *N. carotico-cephalicus* (s. L. 384) hinweg. Er wird vom letzten Zweige des *N. oculomotorius* innervirt.

"Ausser diesen sechs Muskeln des Augapfels besitzen die Vögel und meisten Reptilien noch zwei, welche zur Bewegung des dritten Augenlides dienen.

"7. *M. quadratus membr. nictitantis*, entspringt flach und breit unter und zwischen den Insertionen des *M. rectus internus*, *M. obliquus superior*, und *M. rectus superior*. Er ist von trapezoider Gestalt, indem er an der Basis am breitesten ist und nach dem Sehnerven hin schmäler wird: letzterer Rand bildet eine aponeurotische Schleife für die Sehne des *M. pyramidalis*. Der *M. quadratus* wird vom *N. abduceus* innervirt.

"8. *M. pyramidalis membr. nictitantis*. Entspringt von der unteren inneren nasalen Wand des Augapfels, von den Insertionstheilen des *M. obliquus inferior* und *M. rectus inferior* bedeckt. Der Muskel spitzt sich bald zu, geht median und dorsal vom *N. opticus* in eine runde Sehne über, welche dorsalwärts vom Sehnerven durch die Schleife des *M. quadratus* läuft, dann wieder abwärts geht und zwischen den Insertionen des *M. rectus externus* und des *M. rectus inferior* auf die Vorderfläche des Augapfels tritt, wo die Sehne in

die durchsichtige Nickhaut übergeht. Innervation durch den *N. abduceus.*

"DIE AUGENLIDER [MUSKELN].

. . . . .

"Die Bewegung der Augenlider wird durch mehrere Muskeln bewirkt. Der *M. obicularis,* Sphincter, oder Schliessmuskel läuft kreisförmig unter der Aussenhaut der Lider um die Lidspalte herum und heftet sich an den Lidknorpel an.

"Der *M. levator palpebræ* entspringt vom oberen Dache der Augenhöhle und heftet sich an den äusseren Winkel des oberen Lides.

"Der *M. depressor palpebræ inferioris* ist bedeutend stärker als der vorige, und entspringt in der Tiefe der Augenhöhle. Bei Rhea bildet der Muskel ein langes, breites Band, welches theilweise vom Alisphenoid, und lateral ventral neben dem Ursprung des *M. rectus externus* entspringt. Es inserirt sich hauptsächlich am hinteren, unteren Rande des Lidknorpels.

"Bei den meisten Vögeln (Hühner, Schwimm-, Singvögel) geschieht das Schliessen des Auges durch Heraufziehen des unteren Lides, und das obere Lid bewegt sich sehr wenig, oder gar nicht, wie bei den Reptilien. Selten senkt sich auch das obere Lid etwas durch Contraction des *M. orbicularis,* während das untere sich hebt: Eulen, Caprimulgus, Tauben. Nur in wenigen Fällen, wie beim Strauss und bei den Papageien besitzt das obere Lid grössere Beweglichkeit als das untere, wie bei den Sängethieren. Ueberhaupt ist der Grad der Ausbildung der drei Lidmuskeln ein sehr wechselnder.

"Merrem entdeckte beim Adler noch einen '*Augenbrauenmuskel.*' Er ist sehr dünn, entspringt von einer kleinen Hervorragung des oberen Randes der Augenhöhle und inserirt sich an dem den Tagraubvögeln eigenthümlichen Augenbrauenknochen, den er in die Höhe zu heben scheint.

"Die Innervation der Lidmuskeln geschieht durch den *N. oculomotorius* und durch den R. I. des *Trigeminus.*"

VII. THE MUSCLES OF THE UPPER EXTREMITY.

In describing the muscles of Vertebrates, anatomists usually, after completing their descriptions of the muscles of the head, take up next in order the musculature of the neck and trunk. I have found it to be the case with birds, however, that by far the most convenient method of procedure proves to be to take up *first* our studies and dissections of the muscles of the upper extremity, and, having completed these, turn our attention next to the muscles of the lower extremity, which are to be similarly dealt with, and thoroughly disposed of, before any of the muscles of the trunk proper have been examined.

This course gives us the opportunity of clearing away the very large pectoral muscles of the bird, the heavy muscles of the thigh, and, finally, removing the limbs altogether. We then have nothing left but the much lighter neck and trunk to deal with, which are easier handled, and their muscles worked out with far greater pleasure and satisfaction.

To expose the muscles of the upper extremity we make a circular incision through the integuments at the root of the neck. This is met by a linear incision made on the anterior aspect of the body following the keel of

the sternum, and following midway between the limbs of the furcula. Posteriorly, this linear division of the pectoral integuments is carried well beyond the hinder sternal margin. Next, make a similar median incision upon the dorsal aspect of the body, meeting the circular incision at the root of the neck, and carried posteriorly as far back as the anterior border of the pelvis. Dissect away the skin from the left side of the body, and from the left upper extremity, leaving the right side covered, in order to keep the muscles moist, and intact for comparison, if we find it necessary, with those of the side we have under examination.

Divide the dermal muscles as we come across them, during our operation of removing the integuments, at their middles, allowing the proximal portions to remain, in order that their relations may be studied.

In removing the integumental fold of the patagium carefully study the mechanism of the tendons of the patagii muscles, as well as the muscles themselves. We also find in this fold other small muscular tendons, which will hereafter be described. The relations of the posterior patagial fold should also be carefully studied, as well as the dermal muscles that lie within it. Great care is necessary when you come to remove the skin covering the pinion, as it is intimately attached to the tissues overlying the muscles and tendons beneath it, in several places, which are liable to be injured by the scalpel if the removal is too hastily undertaken, or the skin simply torn off.

THE PECTORAL MUSCLES.

49. The pectoralis major.
50. The pectoralis secundus.
51. The pectoralis tertius.

This group of muscles is second to none in importance as compared with any other in the entire muscular

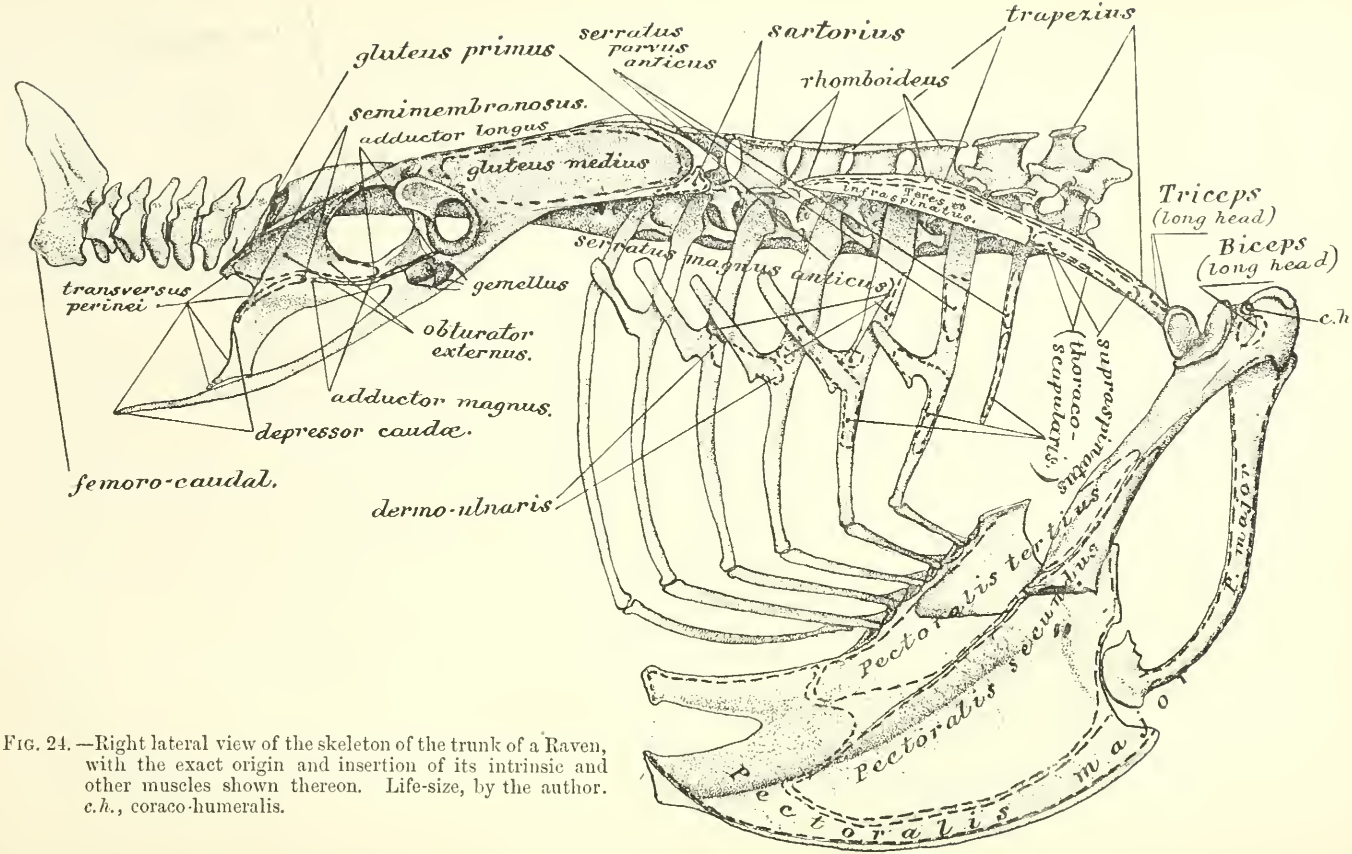

FIG. 24.—Right lateral view of the skeleton of the trunk of a Raven, with the exact origin and insertion of its intrinsic and other muscles shown thereon. Life-size, by the author. *c.h.*, coraco-humeralis.

system of any one of all those birds possessed of the power of flight.

49. *The pectoralis major* [1] is by far the largest muscle

[1] Fürbringer and Gadow divide the *pectoralis major* muscle into three parts, viz. the *pars thoracica*, the *pars propatagialis*, and the *pars abdominalis*.

Omitting the descriptive part, I present the synonymy of these divisions as recorded by Gadow in Bronn's *Klassen des Thier-Reichs*, (vi. Band, pp. 241, 242), which is as follows :—

"73. M. PECTORALIS.

"I. *Pars thoracica.*

Depressor alæ. Borelli.
Grand pectoral. Vicq d'Azyr, 1772, p. 623, No. 1.
,, Cuvier.
,, Gervais et Alix, p. 24 ; Alix, pp. 399–401.
Pectoralis major. Merrem, p. 152 ; Wiedemann, p. 82.
Grosser Brustmuskel. Tiedemann, § 249.
,, ,, Meckel, p. 315, No. 8 ; Schöpss, p. 108, No. 15 ; Prechtl, § 35.
,, ,, Reid, p. 140 ; Rolleston, p. 4.
,, ,, De Man, p. 109 ; Watson, p. 80.
Pectoralis major et minor. Selenka, p. 121, No. 46 u. 47.
Pectoralis. Fürbringer, *Morpholog. Jahrb.*, v., *Monographie* ; Carlsson, p. 26.

"II. *Pars propatagialis* (Fürbringer).

Tensor patagii membran. ant. alæ. Selenka, No. 48 und 49 (partim).
Sehne vom *Pectoralis major* zum *Tensor brevis patag. ant.* De Man, p. 110.
Verstärkendes Sehnenbündel vom *Pect. major.* De Man, p. 111.
Tensor membranæ anterioris alæ, Theil *a* und *b*. Heusinger, p. 185, No. 19.
Langer und Kurzer Muskel der vorderen Flügelfalte. Schöpps, No. 2 und 3 (partim).
Spanner das Windfangs. Prechtl, § 69 (partim).

"III. *Pars abdominalis* (Fürbringer).

Subcutaneus abdominalis. Wiedemann ; Tiedemann, § 100, No. 5.
,, ,, Watson, p. 55.
,, *thoracis.* Tiedemann, § 100, No. 4 ; Prechtl, § 71.

of the system in a Raven, both as regards weight and general bulk. It arises from the posterior moiety of the anterior surface of the sternal body, to the extent shown in Fig. 25 ; from the entire marginal third of the corresponding aspect of the keel, as seen in Fig. 24 ; and finally from the entire outer side of the corresponding clavicular limb of the furcula, as indicated in Fig. 8. The fibres from this extensive origin converge, with but little tendency to overlap as we find them in man, toward the proximal third of the humerus of the same side, into which they are inserted by a broad tendon occupying the entire surface of the palmar aspect of the pectoral crest. The posterior surface of the pectoralis major is far more tendinous in structure than its anterior, and as it passes over the shoulder-joint this tendinous portion becomes intimately blended with the long head of the biceps, while near this point it also receives the insertion of the dermo-humeralis (No. 12), the fan-like tendon of the latter blending with the broad tendon of the pectoralis.

In the sternal region the pectoralis major completely covers the other two pectoral muscles which arise from the sternal body.

This muscle when contracting depresses the humerus with great force, and consequently the wing of the bird, and so forms the chief agent of flight.

In describing the pectoralis major for birds in general, Sir Richard Owen says that "This muscle is very long

Ohne Namen erwähnt. Schöpss, p. 112.
Dermo-humeralis. Owen, p. 24.
Panniculus carnosis (*second portion*). Reid, p. 139.
Muscle des parures. Gervais et Alix ; Alix, p. 401.
" " " Watson, p. 81."

[See the present writer's description of the *dermo-humeralis* in the present connection.]

and wide in the *Natatores* generally, but in the Penguin, its origin is limited to the external margin of the subjacent pectoral muscle, which is here remarkably developed. The great pectoral is very long, but not very thick in the Rasores. In the *Herons* it is shorter, but much stronger and thicker. Its size is most remarkable in the Humming-birds, Swallows, and

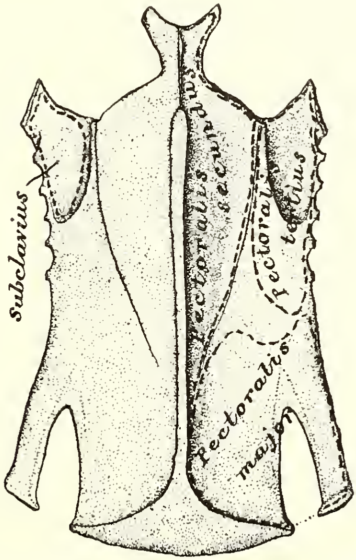

FIG. 25.—Anterior aspect of the sternum of a Raven, designed to show the areas of origin of the pectoral group of muscles. The subclavius lies beneath the *p. tertius*. Life-size, from the specimen.

diurnal birds of prey, where it is attached to almost the whole outer surface of the sternum, and its crest, and has an extended insertion. In the Ostrich its origin is limited to the anterior and external eighth part of the sternum, and it is inserted by a feeble tendon into the commencement of the pectoral crest of the humerus, to which it gives a strong rotary motion forwards. In the Apteryx the *pectoralis major*

is represented by two thin triangular layers of the muscular fibres attached to the under and lateral part of the sternum, and converging to be inserted into the proximal third of the minute humerus" (*Anat. of Verts.*, vol. ii., p. 96).

50. *The pectoralis secundus*[1] (Figs. 24, 25, 26, 29, and 30) arises from the remainder of the keel of the sternum not appropriated by the pectoralis major, as

[1] This is the M. SUPRACORACOIDEUS of Professor Hans Gadow (Bronn's *Klassen*, vi. Band, p. 246), who has given a very full description of it, together with the following synonymy, which I republish below :—

"74. M. SUPRACORACOIDEUS.

Pectoral moyen. Vicq d'Azyr, 1772, p. 624 ; Cuvier.
,, ,, Gervais et Alix, p. 24.
Mittlerer Brustmuskel. Merrem, p. 152, No. 2.
Pectoralis minor. Reid, p. 141.
,, ,, Nitzsch-Giebel (Upupa, Coracias, Papageien).
Pectoralis minor s. medius. Wiedemann, p. 83.
,, ,, ,, ,, Tiedemann, § 250.
,, ,, ,, ,, Heusinger, § 183.
Zweiter Brustmuskel. Meckel, *System*, p. 317, No. 11.
(*Pectoralis secundus*). Haughton (Emu, Rhea).
,, ,, Forbes (Tubinares) ; Weldon (Phœnicopterus et Leptoptilus).
Deltoides maximus. Schöpss, p. 124, No. 21.
Kleiner Brustmuskel (Umroller des Oberarms). Prechtl, § 40.
Pectoralis medius s. secundus. Owen, Apteryx, p. 289.
Subclavius. Rolleston, p. 624.
,, Selenka, Bronn, p. 118, No. 44 ; und *Archiv Néerland.*, 1870, p. 48 ff.
,, De Man, p. 109.
Pectoralis tertius. Jäger Literatur, No. 80.
Pectoralis major (*partim ?*). Rüdinger, p. 89.
Sus-épineux + accessoires du sus épineux. Alix, p. 396–399.
Pectoralis medius. Watson, p. 82.
Supracoracoideus. Fürbringer, *Morphol. Jahrb.*, v. und *Monographie ;* Carlsson, p. 25."

well as from a contiguous strip of the anterior surface of the sternal body. It also finds origin from a tendinous expansion stretching between the corresponding coracoid and the os furcula, and from the anterior sternal extremity of the lower third of the coracoid itself (Fig. 24). From these several points of origin the muscular fibres of the second pectoral rapidly contract as they converge, to pass upward and round the coracoid to its posterior aspect. As they approach the shoulder-joint the carneous fibres become tendinous to form a rounded and strong cord. This passes through the canal formed by the scapula, coracoid, and clavicle, and immediately upon emerging above it is directed outwards and downwards, to be inserted as a strong and somewhat flattened tendon just anterior to the radial crest of the humerus, on the same side but nearer the humeral head than the pectoralis major.

It must not be understood from what I have just said that the fibres of this muscle pass directly to their humeral tendon, for more strictly speaking they gradually merge, as they pass in that direction, into a tendinous sheet which traverses the muscle longitudinally, and appears as a tendinous line upon its anterior aspect.

Through the leverage gained by the tendon of this muscle passing through the osseous canal formed by the bones of the shoulder-girdle, it acts as a levator of the wing, the humerus being raised by its contraction. And this mechanism is very prettily effected in spite of the fact that the chief weight of this muscle is thrown in favour of depressing the centre of gravity of the bird's body, a very essential point to be attained, in fact a positive requirement during flight.

Owen says, "In the Penguins, Guillemots, and Gulls, this muscle is almost the largest of the three, occupying

the whole length of the sternum. It is remarkable for the length and strength of its tendon, which is inserted so as to draw forwards the humerus with great force. It is proportionately the smallest in the *Raptores;* and is very small and slender in the Struthious birds.

"We have already alluded to the use which the Penguin makes of its diminutive anterior extremities as water-wings, or fins; to raise these after making the down-stroke obviously requires a greater effort in water than a bird of flight makes in raising its wings in air; hence the necessity for a stronger development of the second pectoral muscle in this and other diving birds, in all of which the wings are the chief organs of locomotion, in that action, and consequently require as powerful a development of the pectoral muscles as the generality of birds of flight" (*loc. cit.*, p. 97).

Mr. W. A. Forbes says that the pectoralis secundus "in the Albatrosses is unusually short, and broken up into four quite separate parts, which unite before passing the shoulder-pulley. In the other Petrels, the muscle is much more homogeneous, and only separable by dissection into its various component parts" (*Coll. Memoirs*, p. 389).

51. *The pectoralis tertius*[1] is the smallest of the

[1] Gadow (*loc. cit.*, p. 252) prefaces his description of this muscle by the following synonymy, he having proposed the name of the *m. coraco-brachialis posterior* for the *pectoralis tertius:*—

"76. M. CORACO-BRACHIALIS POSTERIOR.

Le petit pectoral. Vicq d'Azyr, 1772, p. 625; Cuvier.
Kleiner Brustmuskel. Merrem, p. 152, No. 3.
Pectoralis minimus. Wiedemann, p. 83.
,, ,, Tiedemann, § 251.
,, ,, Heusinger, p. 183.
,, ,, Prechtl, § 37.
Coracobrachialis inferior. Meckel, *System*, p. 319, No. 12.

pectoral group of muscles, and is found to the outer side of the one last described. As with the first two, its fibres arise fleshy, and in its case, from an area occupying the anterior half (in length) of the outer moiety (in width) of the pectoral aspect of the body of the sternum, including the broad costal process where it is attached to the fascia of the *subclavius* muscle which lies beneath it. It also arises from the outer lower third of the corresponding coracoid process, which latter area lies in close juxtaposition with the somewhat similar origin of the second pectoral (Figs. 24 and 25). From these two origins the fibres of the muscle converge as they ascend upwards, pass to the outer side of the coracoid bone, and as they approach the humerus they become

Pectoralis tertius. Schöpss, p. 113, No. 16.
Coraco-brachialis s. Pectoralis tertius s. minor. Rüdinger, p. 80.
Coraco-brachialis. Reid, p. 141 ; Gervais et Alix, p. 23 ; Alix, p. 393.
Subclavius. Retzius.
Pectoralis minor s. tertius. Owen, Apteryx, p. 289.
Coraco-brachialis longus. Selenka, p. 114, No. 40 ; De Man, p. 106 ; Carlsson, p. 26.
Coraco-brachialis internus. Fürbringer, *Morph. Jahrb.* v.
Pectoralis minor. Watson, p. 83.
Coracobrachialis posterior s. internus. Fürbringer, *Monographie.*"

Valuable observations are passed upon this muscle by the writer just quoted in the same connection, and he, after dwelling upon its anatomy in a number of bird-groups, declares that, "Er entspricht nicht dem *M. coraco-brachialis* des Menschen, der vom Proc. coracoideus zum Schafte des Humerus geht. Besser zu vergleichen ist er einem zweiten *M. coraco-brachialis*, der bei vielen Säugethieren sich am Tuberc. int. humeri besfestigt und bei den Monotremen, die ein Sauropsiden ähnliches Coracoid besitzen, sehr stark und vogelähnlich entwickelt ist. Dass er nicht als ein *Pectoralis minor*, sondern als Corac. brachial. aufzufassen ist, hat Selenka (Literatur, No. 121) ausgeführt. Bei den Amphibien und Reptilien ist er in dem ebenfalls als Coraco-brachialis beschriebenen Muskel zu erkennen" (*loc. cit.*, p. 253).

tendinous, and finally form a strong, somewhat flattened tendon, which is inserted into the ulnar crest of the humerus, on the proximal margin of the pneumatic fossa, at about its middle point.

This muscle assists the pectoralis secundus in elevating the humerus, when it is brought into action by the contraction of its fibres.

Professor Owen seems to have found quite a different origin and insertion in other birds for this muscle, as he says, "the third pectoral muscle, which is in general the smallest of the three, arises from the anterior part of the sternum at the angle between the body and the keel, and also by a more extended origin, from the posterior moiety of the inferior surface of the coracoid and the coraco-clavicular membrane; it is directed forward, rising to pass through the scapulo-coracoid trochlea; its tendon glides through a sheath, attached to the capsule of the shoulder-joint, and in some birds to the os humero-scapulare; and is inserted into the radial tuberosity of the humerus, which it helps to raise. It is proportionally large in the Penguins and Gulls, but attains its greatest development in the Gallinaceous order" (*loc. cit.*, p. 97).

Mr. Forbes, who investigated the myology of the Tubinares, collected during the voyage of the *Challenger*, found the *pectoralis tertius* in them to be "in the form of a broad, thin band, more or less parallel with the coracoid, occupying the superior half of the broad space between that bone and the furcula, its fibres arising chiefly from the strong membrane between these bones, sometimes with additions from the anterior margin of the coracoid, or from the body of the sternum close to the middle line" (*Coll. Memoirs*, p. 390).

Before closing my account of this group of muscles, I

must call attention to one other fact in regard to this third pectoral, and that is this: after having dissected

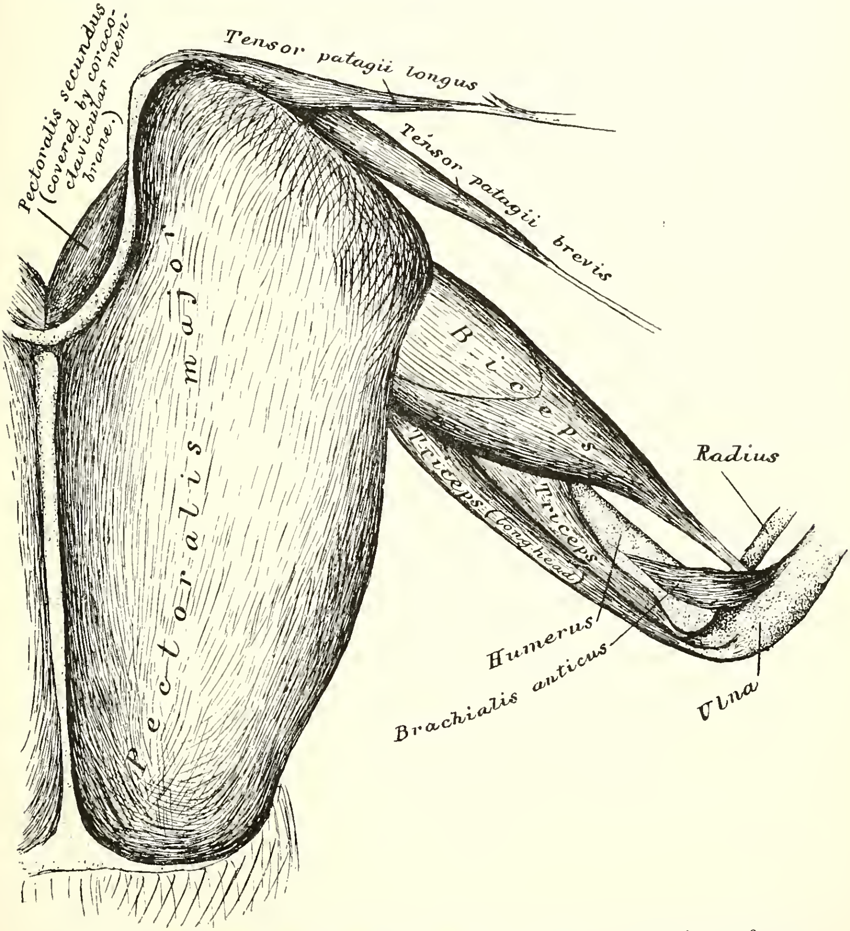

FIG. 26.—Superficial muscles, anterior aspect, of the upper extremity, as far as the elbow, of a Raven. Drawn life-size by the author from his own dissections. All of these muscles are in their normal positions, but the size of the figure did not admit of showing the insertions of the *tensor patagii* slips, though their proximal moieties are shown in their proper positions.

away the pectoralis major, in nearly all specimens, the outer margins of the second and third pectorals appear

as though they were continuous, or a prolongation of the same oblique line ; this is indicated by the shading across the belly of the pectoralis tertius in Fig. 27. In very muscular subjects, however, this muscle does not terminate at this line, but very delicate fibres pass beneath the fascia so as to cover an area of origin as indicated for the pectoralis tertius in Figs. 24 and 25, where its full extent or limit is shown for a very powerfully-developed, old muscular male bird.[1]

DORSAL MUSCLES OF THE UPPER EXTREMITY.

Several of the muscles to be described under this head are generally spoken of by anthropotomists as "muscles

[1] In certain birds there is a small muscle in the axillary region, which I have failed to discover in a Raven, and its place seems to be in some ways replaced by the *dermo-ulnaris* muscle. Mr. Garrod describes it in the following words for *Chauna;* he says the "*Expansor secundariorum* is the name which it is my habit to employ for a very small and peculiar triangular muscle arising from the quills of the last few (generally two or three) secondary remiges at the elbow. Its remarkably long and slender tendon, which frequently traverses a fibrous pulley on the axillary margin of the *teres* muscle, runs up the arm side by side with the axillary vessels and nerves to be inserted in the thorax, into the middle of a tendon which runs from the inner side of the middle of the scapular element of the scapulo-coracoid articulation to near the middle of the thoracic border of the sterno-coracoid articulation, at right angles to it when the fore-limb is extended. This arrangement being found very well differentiated in the Storks may, for the sake of convenience, be termed *Ciconine*" (see *Collected Scientific Memoirs*, 1881, p. 323, and plate showing this muscle in *Chauna*, No 16, where it is marked *e.s.* ; or the same plate in the *P.Z.S.* of 1876, No. xiv.). The author has as yet never examined any of our American *Herodiones* for this muscle.

Since writing this footnote, nearly three years ago, my oppor-

of the back," but, as I have already decided above, it is my intention to consider all those muscles which find

tunities to examine into the literature of this subject have much improved, and (in Bronn's *Klassen des Thier-Reichs*, vi. Band, p. 258) I find a very excellent description of this muscle by Professor Gadow, too long, I regret to say, to reproduce here. This will not apply, however, to the synonymy which he there presents, and which reads as follows :—

" 78. M. METAPATAGIALIS.

Une portion du grand dorsal. Vicq d'Azyr, 1772, p. 632, No. 5.
Tensor membranæ posterioris alæ. Wiedemann, p. 85 ; Tiedemann, § 267.
,, ,, ,, ,, Rüdinger, p. 91.
,, ,, ,, ,, Selenka, No. 50.
Spanner der hinteren Flughaut. Meckel.
M. plicæ alaris posterioris. Schöpss, p. 79, No. 1.
M. coraco brachialis brevis (pt.). Milne-Edwards, *Ossem. fossil.*
M. expansor secundariorum. Garrod, *P.Z.S.*, 1876, pp. 193, 194, und 199.
,, ,, ,, Forbes (Tubinares, p. 29).
M. metapatagialis. Fürbringer."

—(June 14, 1889, R.W.S.)

In October 1887, I published in *The Journal of Comparative Medicine and Surgery* (New York) an essay in which was reviewed the muscles used in the classification of Birds (see No. 124 of *Bibl.* at end of the present volume), and there I made the following comments, and said that "the *expansor secundariorum* (Fig. 35 *bis*, *Exp. Sec.*), although of insignificant size, is a muscle that has proved of no little value as a classificatory one. Garrod spoke of it as the *Ciconine* character, as it was so well developed in the Storks. It occurs in quite a large number of groups of birds, as the *Gallinæ;* the Ducks, Geese, and Swans ; the Rails, Plovers, and many others. While 'in the majority of the Gallinaceous birds the *expansor secundariorum*, with the normal origin from the secondary quills, has a different method of insertion, which has led Mons. A. Milne-Edwards to describe the muscle in the Common Fowl as a part of the *coraco-brachialis* (*brevis*) in his superb work on fossil birds' (Garrod).

"Professor Sutton alludes to this muscle in the following interest-

origin or insertion upon any of the bones of the arm, or the shoulder-girdle, as muscles of the upper extremity. For we cannot clear the subject of this part of its anatomy until these are disposed of, and described.

52. The latissimus dorsi.
53. The trapezius.
54. The rhomboideus.
55. The coraco-humeralis.
56. The scapulo-humeralis.
57. The supraspinatus.
58. The teres et infraspinatus.
59. The serratus magnus anticus.
60. The subclavius.
61. The coraco-brachialis.
62. The teres minor.
63. The levator scapulæ.
64. The thoraco-scapularis.
65. The subscapularis.
66. The serratus parvus anticus.

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ing way. He says, 'Every student of human anatomy must have experienced a certain amount of curiosity when he dissected for the first time the plantaris muscle; this strange structure sinks into insignificance when compared with the celebrated ambiens of the bird's leg, or the tendon of the femoro-caudal in the Lacertilia. Of all strange muscles, the one known as the *expansor secundariorum* (Garrod) in the bird's wing, stands pre-eminent. It is a small triangular muscle, arising from the quills of the last few secondary remiges at the elbow. Its remarkably long and slender tendon, which frequently traverses a fibrous pulley on the axillary margin of the *teres* muscle, runs up the arm side by side with the axillary vessels and nerves, to be inserted in the thorax into the middle of a tendon, which runs from the inner side of the middle of the scapular element of the scapulo-coracoid articulation, to near the thoracic border of the sterno-coracoid articulation, at right angles to it when the fore-limb is extended.

"'In the ducks and geese, among the Anseres, the tendons under consideration, when they enter the thorax, run towards one another and join (after having expanded out), in the middle line in front of the œsophagus, and behind the trachea.

"'My investigations into the morphology of this tendon induce me to believe that it is the representative in the bird's wing of the coraco-brachialis longus of mammals, and the long brachial ligament of man' (*Ligaments, their Nature and Morphology*, p. 33).

"This will prove a very interesting muscle indeed to search for in the various forms of bird life in our own United States avifauna."

52. *The latissimus dorsi*,[1] next to the dermal muscles of the region, is the most superficial muscle of the dorsum.

[1] From Gadow (*loc. cit.*, pp. 226, 227) I obtain the following synonymy of the *latissimus dorsi* :—

"68. M. LATISSIMUS DORSI.

Grand dorsal. Vicq d'Azyr, 1772, p. 631.
" " Cuvier; Gervais et Alix, p. 21.
Hinterer anziehender Armmuskel und Rückwärtszieher des Arms. Merrem, p. 153, Nos. 7, 8.
Latissimus dorsi und *spinalis brachii.* Wiedemann, pp. 84, 85.
Latissimus dorsi. Tiedemann, § 252.
" " Heusinger, p. 183.
" " Meckel, *System*, p. 313.
" " Schöpss, p. 103.
" " Reid, p. 141.
" " Nitzsch-Giebel.
" " Owen, *Apteryx*, p. 288.
" " Selenka, p. 120, No. 45.
" " De Man, p. 109.
" " Fürbringer, *Morphol. Jahrb.*, v.
" " Haswell, *Proceed. Lin. Soc. New South Wales*, 1880, p. 306 ff.; 1883, p. 115; *id.*, *Journal Anat. Phys.*, 1883, p. 219.
" " Gadow (Pterocles, Tauben), *Proc. Zool. Soc.*, 1882, p. 321.
" " Watson, p. 87.
" " Weldon, p. 641; Carlsson, p. 19.
Breiter Rückenmuskel (Rückwärtszieher des Oberarms). Prechtl, § 42.
Latissimus dorsi + *teres major.* Haughton (*Dromæus*, p. 496). *Rhea*, p. 503 *e*, Fig. 35.
Pars metapatagialis (Fürbringer) = pt. *Tensor membranæ posterioris alæ* und *M. plicæ alaris posterioris* der Autoren."

This author splits the *latissimus dorsi* up into "I. Der vordere Theil; II. Der hintere Theil; III. Die *Pars metapatagialis*." These several divisions of the muscle as thus divided receive quite careful description at his hands, while for the physiology of the muscle he republishes the observations of Prechtl, as he does those of Fürbringer for the comparative morphology.

It is well developed in a Raven, and as in the majority of birds, divided into two distinct slips. As a whole, however, it is a thin, fan-shaped muscle, or more properly speaking, a triangular one, with its apex at its insertion upon the humerus, and its base at its origin, attached to the vertebral spines.

The anterior slip arises from the outer edges of the superior margins of the neural spines of that vertebra that bears the last pair of free ribs, and the one next succeeding it, whose ribs articulate with costal ribs; the posterior slip arises from the similar margins of all the following neural spines of the vertebræ of the dorsum, which are four in number. This latter origin partakes very largely of a thin fascia-like character. From this combined origin, the fibres of the intimately connected slips rapidly converge as they pass directly to the *humerus;* they enter between the deltoid, the scapular head of the triceps, and the remaining heads of the latter muscle, to be inserted upon the shaft of that bone, on its anconal aspect, just within the margin of the radial crest, as a flat, ribbon-like muscle in this division of its course (Fig. 27).

53. *The trapezius* [1] lies immediately beneath the

[1] Attention is invited in this connection to Gegenbaur's *Anat. des Menschen*, 1883, p. 311. The following synonymy I take from Gadow (Bronn's *Klassen*, vi. Band, p. 217), who describes the *trapezius* under the name of the *m. rhomboideus superficialis* :—

"65*a*. M. RHOMBOIDEUS SUPERFICIALIS.

Trapézoide. Vicq d'Azyr, 1772, p. 630, No. 1.
Trapèze. Cuvier; Gervais et Alix, p. 21.
Aufzieher des Schulterblatts. Merrem, p. 154, No. 9.
Kappenmuskel *s. Cucullaris.* Wiedemann, p. 84.
" " " Tiedemann, § 242.
" " " Schöpss, p. 90.
" " " Selenka, p. 107, No. 32.

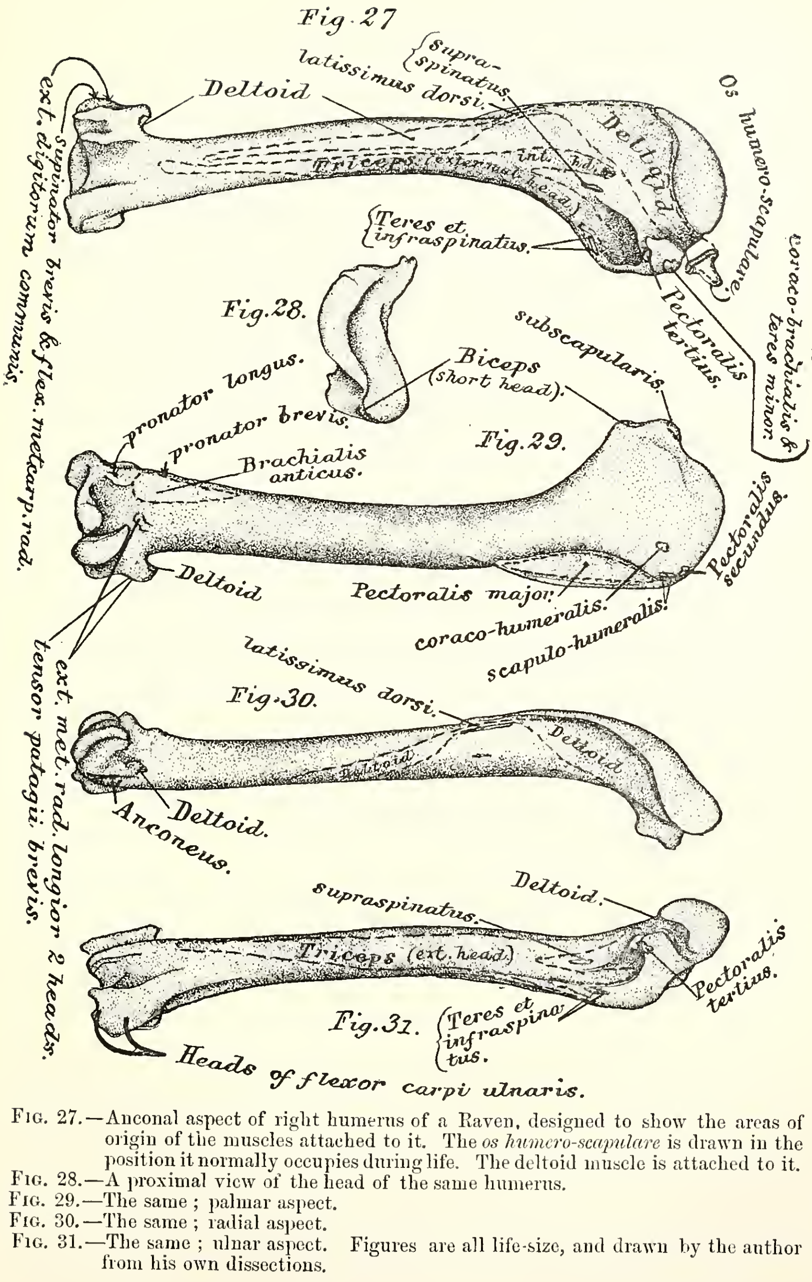

FIG. 27.—Anconal aspect of right humerus of a Raven, designed to show the areas of origin of the muscles attached to it. The *os humero-scapulare* is drawn in the position it normally occupies during life. The deltoid muscle is attached to it.
FIG. 28.—A proximal view of the head of the same humerus.
FIG. 29.—The same ; palmar aspect.
FIG. 30.—The same ; radial aspect.
FIG. 31.—The same ; ulnar aspect. Figures are all life-size, and drawn by the author from his own dissections.

latissimus dorsi for its posterior two-thirds, while the anterior or remaining third is superficial. The muscle is quite well-developed, consisting of a flat layer of fibres, of an oblong figure, which arise just below the latissimus dorsi, on the neural spines of the two vertebræ that bear free ribs, and the next two succeeding vertebræ of the dorsum. From this origin the fibres pass directly across to the scapula to become inserted upon its mesial border to the extent shown in Figs. 8 and 24. The posterior moiety of the trapezius overlies the anterior portion of the rhomboideus muscle, but the direction of their fibres is different, as those of the latter pass backward and outwards, while, as I have said, those of the present muscle pass directly across to their insertion (Fig. 33).

54. *The rhomboideus*[1] in man and most mammals

Kappenmuskel *s. Cucullaris.* De Man, p. 103.

Oberflächlicher Ein- und Rückwärtszieher. Meckel, *System*, p. 306, No. 1.

Trapezius. Watson, p. 76; Weldon, p. 641.

Rhomboides pt. (*cucullaris*). Fürbringer, *Morph. Jahrb.*, v.

Rhomboides superficialis. Fürbringer, *Morph. Jahrb.*, xi., und *Monographie.*

Rhomboideus inferior. Weldon, p. 641."

Gadow further adds (Bronn's *Klassen*, p. 218) that "Dieser Muskel, der bei den Vögeln passend als *M. spini-scapularis* bezeichnet werden kann, ist als ein oberflächlicher Theil des Rhomboideus der Säuger zu betrachten, daher nicht, wie bisher fast allgemein geschehen, mit dem Cucullaris zu verwechseln. Zurückführüng auf Amphibien und Reptilien ist schwierig, da er wohl mit dem wahren Cucullaris eine noch nicht differenzirte Masse bildet, jedoch lässt er sich nach Fürbringer mit der gleichnamigen Bildung der Crocodile homologisiren."

[1] "65*b*. M. RHOMBOIDEUS PROFUNDUS.

Rhomboide. Vicq d'Azyr, 1772, p. 630; Cuvier; Gervais et Alix, p. 21.

is represented by two distinct muscles, while in birds it is invariably a single one. It is absent altogether in the *Apteryx*. Here in the Raven, it arises from the neural spines of the first four dorsals, or at least from the spines of the leading four vertebræ, that possess completed ribs. This origin lies beneath that of the latissimus dorsi and the trapezius muscles, where they overlap it. The fibres pass backwards and outwards to insert themselves upon the posterior third of the mesial border of the scapula, commencing anteriorly about where the trapezius leaves off, the overlapping of these two muscles, in all the specimens I have examined, being at their origins only.

On the upper side of the shoulder-joint we find in the Raven two very slender muscular slips, passing from the shoulder-girdle to the humerus. They both act as *levators* of the brachium, and perhaps too, to a certain extent, counteract each other in pulling the humerus forwards and backwards.

Rautenmuskel (*rhomboideus*). Wiedemann, p. 82.
" " Meckel, *System*, p. 307.
" " Schöpss, p. 92.
" " Selenka, p. 108, No. 33.
" " De Man, p. 104.
" " Watson, p. 77.
" " Carlsson, p. 17.
Rhomboideus major et minor. Tiedemann, §§ 243, 244.
Rhomboides pt. (*rhomboideus*). Fürbringer, *Morph. Jahrb.*, v.
Rhomboideus profundus. Fürbringer, *Monographie*.
Rhomboideus superior. Weldon, p. 641." (See Gadow in Bronn's *Klassen des Thier-Reichs*, vi. Band, pp. 218, 219.)

"Der Rh. profundus stellt eine secundäre Differenzirung des Serratus profundus dar, die bei manchen Vögeln (z. B. mehreren Ratiten) noch keine volle Selbstständigkeit gewonnen, bei anderen (z. B. Pici und Capitoniden) noch weiter gehende Sonderungen und Zerfallbildungen erkennen lässt" (Fürbringer).

As a rule, these muscles are not fully described in works devoted to the myology of birds, and until such time as the homologies in myology are better known, I have bestowed the following names upon these two little muscular slips:—

55. *The coraco-humeralis*,[1] the smaller and more anterior of the two, arises from the outer side of the head of the coracoid, above and rather posterior to the origin of the long head of the biceps (Fig. 24, *c.h.*). Its fibres form a delicate, subcylindrical cord that passes to the head of the humerus to become inserted upon its palmar aspect, beyond and to the inner side of the insertion of the pectoralis major (Fig. 29).

56. *The scapulo-humeralis*[2] (Fig. 8) arises from the

[1] Fürbringer defines this muscle as the *coracobrachialis anterior s. externus*, in his magnificent work upon the morphology of the class Aves; and Gadow presents us with the following synonymy:—

"75. MUSCULUS CORACO-BRACHIALIS ANTERIOR.

Le muscle qui correspond au coraco-brachial. Vicq d'Azyr, 1773, p. 568, No. 5.
Deltoideus inferior. Schöpss, p. 122, No. 20 (partim).
Deltoideus minor. Heusinger, p. 183, No. 6.
Coraco-brachialis proprius s. pectoralis medius. Rüdinger, p. 89.
Deltoideus minor. Selenka, p. 117, No. 43.
Coracobrachialis anterior s. externus. Fürbringer (*loc. cit.*, p. 251)."

[2] According to Gadow (*loc. cit.*, p. 234) this muscle represents the *deltoideus minor* of Fürbringer, and he gives the following synonymy of it:—

"70. M. DELTOIDEUS MINOR.

Le petit releveur de l'humerus. Vicq d'Azyr, 1773, p. 567.
Levator humeri. Tiedemann, § 255 (?).
,, ,, Heusinger, p. 183, No. 7.
Deltoideus externus. Schöpss, p. 120, No. 19.
Kleiner deltaförmiger Muskel (Vorwärtszieher des Oberarmes). Prechtl, § 39.
Deltoideus minor. De Man, p. 108.

inner side of the neck of the scapula just within the origin of the deltoid; its fibres form a narrow, flattened ribbon, that passes over the top of the shoulder-joint, parallel to the upper margin of the larger portion of the deltoid, to become inserted on the palmar aspect of the humeral head, directly between the insertions of the pectoralis major and secundus (Fig. 33, *s.h.*).

Professor Owen describes for the *Apteryx* a *subscapularis* muscle as arising "from the anterior part of the inner surface of the scapula, and is inserted into the ulnar humeral tuberosity." I might have considered this the same as the muscle described above as my *scapulo-humeralis*, but the eminent anatomist just quoted says further that the *subscapularis* is divided into two portions by the *pectoralis minor*.

Unfortunately, I have not Professor Owen's drawings of the myology of *Apteryx* before me at the present writing, but it is difficult for me to understand from his description in *The Anatomy of Vertebrates*, how the muscle he calls the *subscapularis* can be "divided into two portions by the *pectoralis minor*," when he says of the latter that "A muscle, which may be regarded either as a portion of the *pectoralis minor*, or as the analogue of the *subclavius* muscle, arises from the anterior angle of the sternum, and is inserted into the external margin of the sternal extremity

Deltoideus minor. Fürbringer; Carlsson, p. 20.
Accessoire coracoidien du sus-spineux. Alix, p. 399 (?)."

Considerable confusion has attended the identification of this muscle, and the *deltoideus minor* of Selenka (Bronn's *Klassen*, vi. Band, p. 117) is not taken by Gadow to be the muscle he describes under that name, and the present writer is satisfied that the *d. minor* of Gadow is the muscle described above as the *scapulo humeralis*.

of the coracoid bone" (*Anat. Verts.*, vol. ii. p. 95). Of course it is hard for me to judge, as I say, in the absence of Professor Owen's figure, but if the fibres of this *subclavius* muscle have the same direction as his *pectoralis minor*, then it is hard to see how they could divide the *subscapularis* in two portions, which pass between the scapula and the humerus. (For the way these muscles occur in the Raven, see No. 60 *et seq.*)

57. *The supraspinatus*[1] (Figs. 24, 27, and 34) is a thin, flat muscle of a triangular form, its base being represented by its origin, and its apex by its insertion. It arises from the superior surface and outer

[1] "Recht stark entwickelt ist der Muskel bei *Corvus*," says Gadow, in speaking of the *supraspinatus*, which he describes in Bronn's *Thier-Reichs* as the *scapuli-humeralis anterior*, with the subjoined synonymy (vi. Band, p. 235):—

"71*a*. M. SCAPULI-HUMERALIS ANTERIOR.

L'huméro-scapulaire. Vicq d'Azyr, 1773, p. 569.
Schulterarmmuskel. Wiedemann, p. 86.
„ Prechtl, § 41.
Humero-scapularis parvus. Tiedemann, § 257.
„ „ „ Heusinger, § 184.
Supraspinatus, oder *Teres minor ?* Meckel, *System*, p. 312, No. 6.
„ „ „ „ Schöpss, p. 107.
Teres minor. Reid, p. 142; Nitzsch-Giebel.
Subscapularis (*inferior posterior*). Macalister, p. 16.
Infraspinatus. Retzius, Selenka, p. 113, No. 38.
„ De Man, p. 106; Carlsson, p. 19.
Teres minor s. Infrascapularis. Gurlt, p. 21.
Le petit rond. Gervais et Alix, p. 22.
Supraspinatus. Rüdinger, p. 86.
„ Watson, p. 85.
„ Weldon, p. 643.
Infraspinatus. Fürbringer, *Morph. Jahrb.*, v.
Scapulo-humeralis anterior. Fürbringer, *Monographie.*"

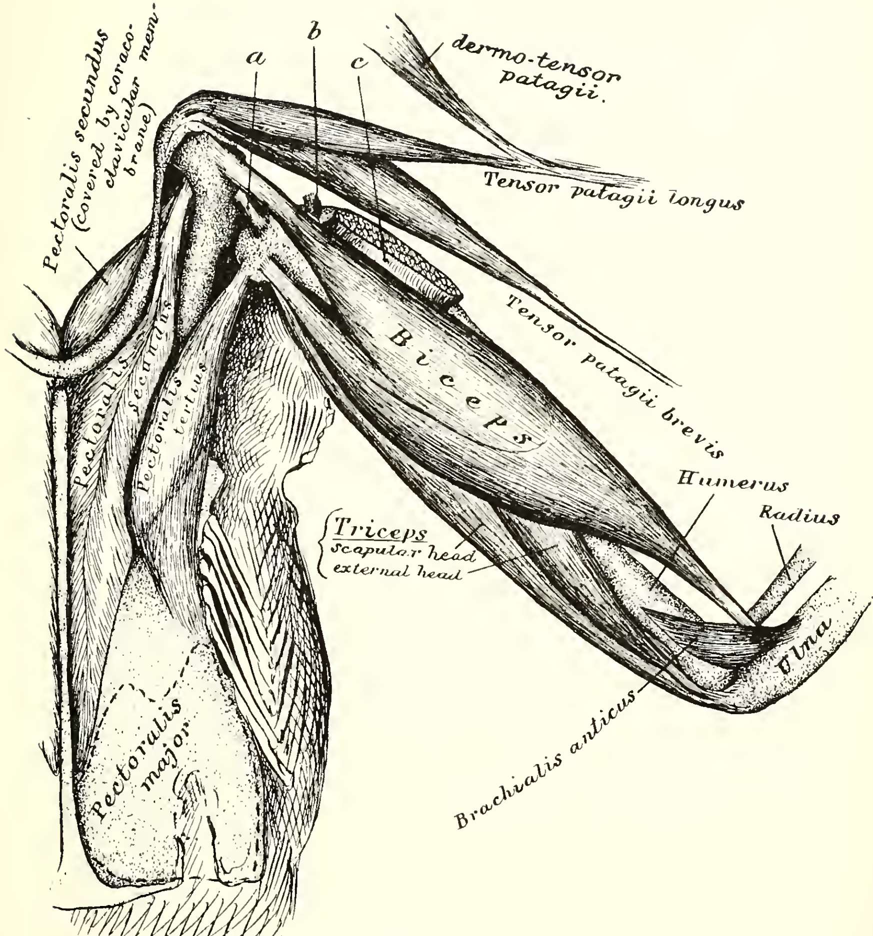

FIG. 32.—Anterior aspect of a number of muscles of the upper extremity, and more particularly designed to show *in situ* the *pectoralis secundus* and *tertius*, and the *biceps*. The *pectoralis major* has been almost entirely removed. *a*, the end of cut tendon of *pectoralis secundus*; *b*, its humeral stump; *c*, the humeral stump of the *pectoralis major*. Life-size, from an adult female Raven, by the author, from his own dissections.

rounded margin of the scapula, posterior to the origin of the long head of the triceps, for about the anterior

third of the blade of the bone. Its fibres converge to pass directly to the corresponding humerus, to become inserted upon the anconal aspect of the bone, just within the border of the lower part of the pneumatic fossa, below the origin of the deltoid, and between the forks of the external and internal heads of the triceps, which really seems to divide to give it space to make fast to, as shown in the figures.

58. *The teres et infraspinatus*[1] is the name I have

[1] As will be seen in my Preface to the present volume, I was far removed from nearly all books, and from all libraries and anatomists, when it was written, and when this muscle was primarily described by me. So when the synonymy of these parts as collected by Gadow recently came to my hands, it was with no little interest that I noted that the muscle now under consideration, as proves to be the case in quite a number of others I was obliged under those circumstances to bestow names upon, had already received the name I coined for it by Tiedemann, by Heusinger, and by Schöpss.—(14th June, 1889.)

The following is its synonymy by Gadow (Bronn's *Klassen des Thier-Reichs*, vi. Band, pp. 236, 237) :—

"71*b*. M. SCAPULI-HUMERALIS POSTERIOR.

Sus-scapulaire. Vicq d'Azyr, 1772, p. 631.
Schulterblattmuskel. Merrem, p. 154 ; Prechtl, § 38.
Ober-Schulterblattmuskel. Wiedemann, p. 87.
Supra-scapularis (*Infraspinatus* + *teres major*). Tiedemann, § 256.
,, ,, ,, ,, ,, Heusinger, p. 184.
Suprascapularis. Gurlt, p. 21.
Untergrätenmuskel. Meckel, *System*, p. 312, No. 5.
Infraspinatus s. teres major. Schöpss, p. 105.
Infraspinatus. Reid, p. 141 ; Owen, *Apteryx*, p. 288 ; Watson, p. 86.
Teres major. Retzius ; Selenka, p. 113, No. 37 ; De Man, p. 105.
,, ,, Fürbringer, *Morph. Jahrb.*, v. ; Carlsson, p. 19.
Teres minor. Macalister, p. 16.
Le grand rond. Gervais et Alix, p. 22.
,, ,, ,, Alix, p. 394.
Scapulo humeralis posterior. Fürbringer."

bestowed upon the present muscle, as it seems to combine the *teres major* and the *supraspinatus* of such vertebrates wherein these muscles are found separate. Even in old muscular subjects among the Ravens, one is almost led to believe that the two can be fairly distinguished, the division being indicated by a somewhat broader dividing fascia.

The *teres et infraspinatus* possesses fully four or five times the bulk of the *supraspinatus*, and is the largest muscle, by all odds, that is attached to the shoulder-blade (see Figs. 24, 27, and 34).

It arises from the superior surface and the outer margin of the hinder two-thirds of the scapula, extending in fact between the posterior termination of the supraspinatus to the apex of the bone. Its fibres rapidly converge as they pass forwards and outwards to their point of insertion upon the corresponding humerus. This is found upon the anconal surface of that bone at about the middle of the free ulnar margin of the pneumatic fossa; the external head of the triceps forking to allow this muscle room to attach itself (Fig. 27).

Owen says in the *Apteryx* that it "is inserted into the ulnar tuberosity of the humerus, where it is closely attached to the capsule of the shoulder-joint."

The major portion of both of these last-described muscles lie beneath the latissimus dorsi, the *supraspinatus* being the less covered of the two (Fig. 33).

Chief among the uses of these muscles is the protection they afford the shoulder-joint, and acting as braces they greatly assist keeping the humerus in its shallow socket. After the wing has been extended, they, by their contraction, assist to close it again by drawing the humerus towards the side of the body. They are

also useful in some of the movements of the brachium during flight; and it must be evident to meet any of these ends, the *supraspinatus* is the one possessing the least power, while the *teres et infraspinatus*, from its greater size and more favourable origin, is the more powerfully endowed.

59. *The serratus magnus anticus*[1] is composed of

[1] In dealing with the *serrati* group of muscles in birds, Gadow divides his *m. serratus superficialis s. thoraci-scapularis* into three parts, viz.:—I. the *pars anterior*, II. the *pars posterior*, and III. the *pars metapatagialis*. His work (Bronn's *Klassen*, vi. Band, pp. 221–224) presents descriptions of these several divisions, to which the student is referred, and records the subjoined synonymy, herewith republished:—

"66*b*. M. SERRATUS SUPERFICIALIS S. THORACI-SCAPULARIS.

"I. *Pars anterior.*

Costo-scapulaire. Vicq d'Azyr, 1772, p. 629; Cuvier.
Costo-scapularis inferior. Wiedemann, p. 87.
Costo-scapularis. Tiedemann, § 247.
Kleiner Brustmuskel oder vorderer sägeförmiger Muskel. Meckel, *System*, p. 308, No. 7; Schöpss, p. 96.
Serratus magnus anticus (*first portion*). Owen, *Apteryx*, p. 288.
Serratus anticus (*pt.*). Selenka, p. 110, No. 35.
,, ,, ,, De Man, p. 105; Carlsson, p. 18.
Grand dentelé antérieur. Gervais et Alix, p. 20.
Serratus anticus minor. Watson, p. 78.
Serratus superficialis, pars anterior. Fürbringer.

"II. *Pars posterior.*

Sous-scapulaire. Vicq d'Azyr, 1772, p. 632.
Grand dentelé. Cuvier.
Rückwärtszieher des Schulterblattes. Merrem, p. 154.
Serratus. Wiedemann, p. 87.
Serratus magnus. Tiedemann, § 246.
,, ,, Fürbringer, *Morph. Jahrb.*, v.
,, ,, Weldon, p. 641.
Grosser, vorderer Sägemuskel. Meckel, *System*, p. 308, No. 6.
,, ,, ,, Schöpss, p. 94.

three strong digitations, each of considerable bulk. The first of these slips arises from the outer aspect of the second true dorsal rib (counting from before backwards) rather above the base of its epipleural appendage. The other two slips arise from similar points on the next two succeeding ribs, just above the origin of the *dermo-ulnaris*. The extremities of these digitations of the *serratus magnus anticus*, are strongly inclined to partake of a tendinous character, and the first two may be more or less attached to the interpleurapophysial membrane. They converge as

Serratus magnus anticus (*middle and posterior portion*). Owen, *Apteryx*, p. 288.
Serratus anticus (*pt.*). Selenka, p. 110, No. 35.
„ „ . De Man, p. 105.
Grand denteté postérieur. Gervais et Alix, p. 20.
Serratus anticus major. Watson, p. 77.
Serratus superficialis, pars posterior. Fürbringer.

"III. *Pars metapatagialis.* Fürbringer.

(*pt.*) *Tensor membranæ posterioris alæ.* Wiedemann; Tiedemann, § 267.
„ „ „ „ Rüdinger, p. 91.
„ „ „ „ Selenka, p. 123, No. 50; Carlsson, p. 18.
(*pt.*) *M. plicæ alaris posterioris.* Schöpss, p. 79."

If the reader will refer to my *dermo-ulnaris* (No. 11 of the present work) he will find that that muscle represents the *pars metapatagialis* of the above synonymy; so that the synonyms here will probably stand thus—

Shufeldt.		Gadow.	
No. 59, *Serratus magnus anticus*	=	I. *Pars anterior.*	66*b*. *M. serratus superficialis s. thoraci-scapularis.*
No. 64, *Thoraco-scapulæ* (in pt.) No. 66, *Serratus parvus anticus* (in part)	=	II. *Pars posterior.*	
No. 11, *Dermo-ulnaris*	=	III. *Pars metapatagialis.*	

they pass upwards and slightly forwards, and are inserted on the inferior surface of the apex of the corresponding scapula (see Figs. 24, 34, and others).

60. *The subclavius*[1] muscle arises from the entire outer surface of the costal process of the sternum and the contiguous outer surfaces of three or four of the hæmapophyses, in which situation it is largely overlapped by the pectoralis tertius. Its outermost sheath of fascia is attached to the inferior external margin of the corresponding coracoid bone, but its short and oblique muscular fibres pass over this to be inserted and fill the fossa that is found at the lower third of the posterior aspect of the coracoid. When this muscle contracts it simply pulls the coracoid very slightly outwards, the bone sliding along upon the articulation of its sternal bed. The more important function of

[1] Both Fürbringer and Gadow describe this muscle as the *sterno-coracoideus*, while originally it was considered by Tiedemann and Schöpss to be the *subclavius*.

Gadow presents us with the following synonymy for it (Bronn's *Klassen des Thier-Reichs*, vi. Band, pp. 224, 225):—

"67. M. STERNO-CORACOIDEUS.

Le claviculaire court. Vicq d'Azyr.
Rückwärtszieher der Schlüsselbeine. Merrem.
M. clavicularis externus. Wiedemann.
M. subclavius. Tiedemann, § 248.
,, ,, Schöpss.
Ohne Namen, oder vielleicht kleimer vorderer Sägemuskel. Meckel, *System*, p. 308, No. 8.
Pectoralis minor. Retzius.
Subclavius s. pectoralis minor. Rüdinger, p. 89.
Serratus anticus minor. Owen, *Apteryx*, p. 288.
Coraco-sternalis. Selenka, p. 111, No. 36.
,, ,, De Man, p. 105 ; Carlsson.
Sterno-coracoideus. Fürbringer, *Morph. Jahrb.*, v., xi., und *Monographie.*"

the muscle consists in keeping the coracoid firmly in place and preventing its dislocation during violent action of surrounding muscles (see Figs. 8 and 25).

61. *The coraco-brachialis*[1] (Figs. 8 and 27) is a long fusiform muscle that arises by a delicate tendon

[1] My dissections of the *coraco-brachialis* in *Corvus* convinced me that it had the same origin and insertion described for it by Owen (*Anat. Verts.*, vol. ii. p. 97); but I find that Gadow, who calls the muscle the *subcoracoideus*, finds a different arrangement of things, for he says that, "Bei *Corvus*, *Garrulus*, und *Paradisea* entspringt ein Theil von Binnenseite und dem Vorderrander des Sternum und von der Innenfläche des benachbarten Coracoidtheiles; ein anderer Theil kommt vom Proc. furcularis des Coracoids und der Scapula. Beider Theile Sehnen inseriren sich vereinige dicht am Caput humeri etwas proximal von der Sehne des Subscapularis" (Bronn's *Klassen des Thier-Reichs*, vi. Band, p. 239). Gadow agrees with Owen in that the *coraco-brachialis* is missing in *Struthio* and small in the *Apteryx*.

He presents us with the following synonymy for it (*loc. cit.*, p. 238):—

"72*a*. M. SUBCORACOIDEUS.

Souclavier interne. Vicq d'Azyr, p. 628.
Vorderer anziehender Armmuskel. Merrem, p. 153.
Ohne Namen. Meckel, *System*, p. 320, No. 13.
Coraco-brachialis superior. Schöpss, p. 115, No. 17.
Coraco-brachialis brevis. Milne-Edwards; Selenka, p. 115, No. 41.
" " " De Man, p. 106 (2. Portion); Carlsson, p. 18.
Coraco-brachialis. Owen, *Apteryx*, p. 289; Watson, p. 84; Gurlt.
L'accessoire coracoidien du sous-scapulaire. Gervais et Alix, p. 23.
Coraco-brachialis externus. Fürbringer, *Morph. Jahrb.*, v.
Sub-coraco-scapularis (*Pars coracoidea*) = *M. subcoracoideus*. Fürbringer, *Morph. Jahrb.*, xi., und *Monographie*."

Authors appear to describe *two* portions of this muscle, of which my *coraco-brachialis* is one; Selenka says of his *Coracobrachialis brevis* (No. 41) that "Die älteren Beschreibungen dieses Muskels sind sämmtlich mangelhaft und verwirrt, viele sonst ausführliche Arbeiten nennen ihn nicht einmal. Cuvier spricht nur allgemein

from a small circular origin situated at the postero-mesial aspect of the shaft of the coracoid, immediately above the fossa which harbours the insertion of the subclavius. Its fibres pass almost directly upwards parallel with the coracoidal shaft, and as they near the head of the humerus they again become tendinous, and are finally inserted on the top of the ulnar tuberosity, on a diminutive subcircular space, common to it and the insertion of the teres minor.

Owen tells us that "This muscle is wanting in the *Struthionidæ*, is of small size in the Heron and Goose, is much more developed in the *Raptores* and many *Natatores*, especially the Penguins, and attains its greatest relative size in the *Rasores*, where it arises from almost the whole of the coracoideum."

62. *The teres minor*[1] arises fleshy from the under side of the anterior tip of the scapula, the clavicular process of the bone, to the extent shown in Fig. 8. The fibres, forming a chunky, little muscle, pass directly outwards, *behind* the coracoidal head, and *beneath* the neck of the scapula. Clearing these two bones the fibres rapidly converge to form a small tendon, which is intimately fused with the tendon of the *coraco-brachialis*, and consequently makes the same

von zwei Muskeln, die am *Os coracoideum* entspringen und am Humeruskopfe sich inseriren ; das sind die beiden hier als *Coracobrachiales* beschriebenen Muskeln. Tiedemann führt einen *Deltoideus minor* und *Levator humeri* auf, dei zum Theil wenigstens dem *Coracobrachialis brevis* entsprechen. Auch Gurlt, Wiedemann, Merrem, Aldrovandi erwähnen den Muskel nicht" (Bronn's *Klassen des Thier-Reichs*, vi. Band, p. 115).

[1] Possibly this muscle corresponds to the *subscapularis internus* of Gadow's "72*b*. M. SUBSCAPULARIS," and attention is invited to the muscle I describe below as the *subscapularis* (No. 65), and the footnote under it.

insertion on the top of the ulnar tuberosity of the corresponding humerus.

To a limited degree, the coraco-brachialis and teres

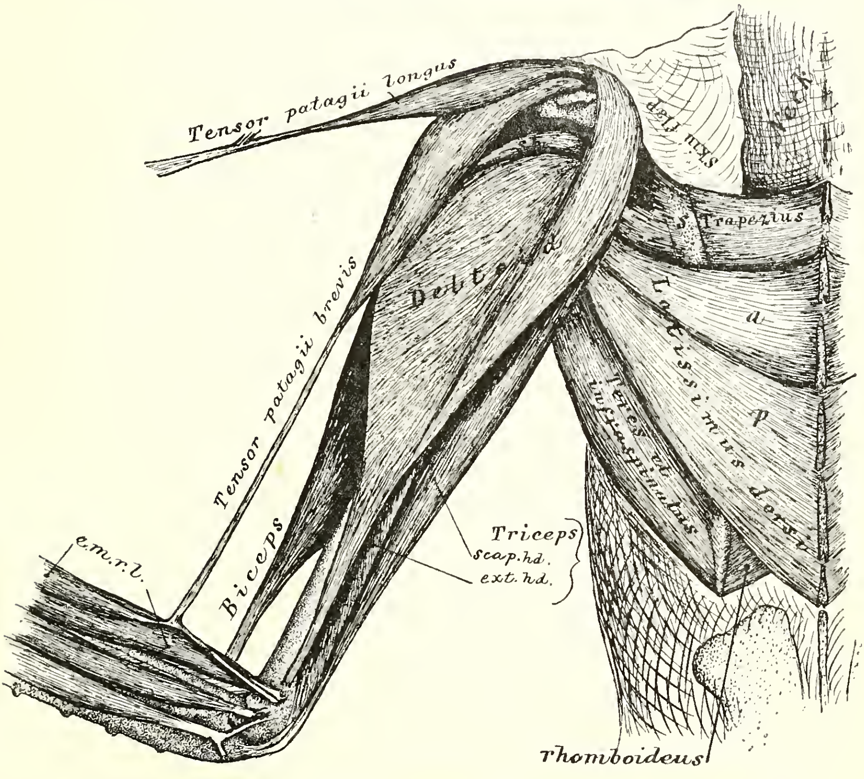

FIG. 33.—Superficial muscles of the upper extremity in the region of the shoulder and dorsum of a Raven. *s*, scapula; *a*, anterior slip of the latissimus dorsi; *p*, its posterior slip. The head of the coracoid can be seen where the mesial extremities of the patagii muscles pass over it; *s.h.*, the scapulo humeralis muscle. The extensor metacarpi radialis longus muscle is indicated by the letters *e.m.r.l.* Life-size, by the author, from his own dissections.

minor assist the pectorals in their action in the downward stroke of the humerus, and so the wing, but they also assist in keeping that bone in its shallow glenoid cavity.

In all of the works at my disposal I fail to find a description of this teres minor muscle, and consequently have taken the responsibility of naming it myself. In its origin, insertion, and action, it seems to correspond quite closely with the teres minor of many of the higher vertebrates, in arising near the neck of the scapula and being inserted upon the tuberosity of the humerus.

Mivart says that the teres minor may coalesce with the infraspinatus, as in the Two-toed Ant-eater. The *minor* may be larger than the *major*, as in the Horse (*Elem. Anat.*, p. 326).

63. *The levator scapulæ*[1] arises by two strong, fleshy digitations, one from each of the lateral processes

[1] This is the *serratus profundus* of Fürbringer and Gadow, and the latter presents us with a very full description of it (*loc. cit.*, pp. 220, 221), together with the following synonymy :—

"66*a*. M. SERRATUS PROFUNDUS.

Anzieher des Schulterblattes. Merrem, p. 154.
Costo-scapularis superior. Wiedemann, p. 87.
Levator scapulæ. Tiedemann, § 245.
" " Selenka, p. 109, No. 34.
" " De Man, p. 104; Fürbringer, *Morph. Jahrb.*, v.; Watson, p. 79; Weldon, p. 641; Carlsson, p. 17.
Schulterheber. Meckel, *System*, p. 307.
" Schöpss, p. 97.
L'angulaire. Gervais et Alix, p. 20.
Serratus profundus. Fürbringer.

"Rüdinger bemerkt ganz richtig, dass in Folge seines Ursprungs von den Rippen dieser Muskel eine wesentliche Abweichung vom Levator scapulæ der Saüger bietet, da er bei letzteren von den hinteren Zacken der Querfortsätze der ersten 4 Halswirbel entspringt. Er entspringt dagegen ziemlich genau dem *M. collo-scapularis* der Reptilien, wenn man die Länge des Vogelhalses in Betracht zieht. Der Serrat. prof. (Levator scapulæ der Autoren)

of those vertebræ that support the free pairs of ribs; the fibres slightly converge as they pass directly backwards to become inserted into the middle third of the inferior aspect of the blade of the corresponding scapula. When this pair of muscles contracts they will evidently pull the scapulæ directly forwards, and with it, of course, the entire shoulder-girdle, which will articulate like a hinge-joint at the coraco-sternal junction.

Owen says that "the levator scapulæ arises by digitations from the pleurapophyses of the last cervical, and the first two dorsal vertebræ; it is inserted into the posterior part of the dorsal edge of the scapula, which it pulls forwards. In the Apteryx it seems to be the most anterior portion of the series of fasciculi composing the *serratus magnus anticus*." It will be seen from this description that both its origin and insertion is very different in the Kiwi-kiwi from what it is in the Raven.

64. *The thoraco-scapularis* [1] is the name I here bestow upon that muscle in *Corvus corax* which arises from the outer aspect of the lower half of the ultimate free rib; from the middle of the outer side of the next succeeding rib, or true dorsal, and its epipleural

zeigt in Gegensatze zu den Reptilien namentlich bei den Carinaten eine gewisse Vereinfachung, die z. Th. dadurch entstanden ist, dass ein Theil von ihm sich als besonderer Muskel (Rhomboideus profundus) differenzirt und abgetrent hat" (Gadow quoting Fürbringer, p. 221).

[1] Probably the muscle here described is the *pars posterior* (in part) of Gadow's *m. serratus superficialis s. thoraci-scapularis*, the synonymy of which is given under the *serratus magnus anticus* of the present memoir, No. 59 (which see).

The remaining part of the *pars posterior* of Gadow's *m. serratus superficialis*, appears to be herein represented by my *serratus parvus anticus* (No. 66), and the reader's attention is also invited to that muscle.

appendage; and finally by another digitation, the largest of the three, from a like origin on the outer surface of the following rib. These three digitations form a broad, flat muscle lying close against the parietes of the thorax. Its fibres converge and pass upwards and forwards, but as they enter the scapulo-thoracic space they become converted into a broad, thin, flat tendon, which, passing between the two divisions of the subscapularis, is inserted on a line, covering the junction of the middle and anterior thirds of the outer margin of the corresponding scapula (Fig. 24). This muscle, when the ribs are fixed, draws down the scapula to the side of the chest, but when the shoulder-girdle is fixed by the opposing set of muscles, it draws up the ribs to which it is attached, and thus increases the capacity of the chest, and performs an important function in the act of inspiration.

From what I quoted from Sir Richard Owen, above, it would seem that this muscle corresponded with his *pectoralis minor*, and if we be permitted to compare the two, it seems to correspond even with the pectoralis minor in a man, but a far greater amount of study will have to be undertaken than has been done up to the present time, before we can say much about such homologies.

Mivart says of the *pectoralis minor* that "the smaller pectoral is a much less constant muscle than the large one, being very frequently absent. Even in animals closely allied to man (*e.g.* many Apes) it is inserted into the capsular ligament of the humerus instead of into the coracoid process. It may form one with the pectoralis major, as in birds" (*Elem. Anat.*, p. 326). It will be seen that this last statement of this authority cannot be reconciled with what we have found to be the

case in the Raven and many other birds. Any way we may regard it, however, the fact still remains that in many vertebrates, we have a muscle that passes from the middle outer surfaces of some of the leading ribs, to become attached to some part of the shoulder-girdle, or scapular apparatus, and that this muscle is an important one in inspiration. We may call it the *pectoralis minor*, or the *thoraco-scapularis*, as I have in the present instance, as we may please.

65. *The subscapularis*[1] is one of the largest and most powerful of the muscles in the *Corvidæ*, and is well

[1] See No. 62 of the present memoir in this connection (the *teres minor*), and the muscle here described appears to be the I. (*subscap. externus*) of Fürbringer and Gadow, or in other words, as near as I can make it out, my *teres minor* + (my) *subscapularis* = the *subscapularis* (with internal and external part) of Fürbringer. Gadow (Bronn's *Klassen*, vi. Band, pp. 240, 241) presents us with the following valuable study of the subject :—

" 72*b*. M. SUBSCAPULARIS.

Sousclavier externe. Vicq d'Azyr, 1772, p. 628.
Vorderer anziehender Armmuskel. Merrem.
Sous-scapulaire. Cuvier ; Gervais et Alix, p. 22.
Unter-Schulterblattmuskel (*subscapularis*). Wiedemann, p. 89 ; Schöpss, p. 128, No. 22 ; Meckel, *System*, p. 321.
? Deltoideus externus. Schöpss.
Subscapularis. Reid, p. 142.
,, Rüdinger, p. 87.
,, Macalister (*superior posterior*), p. 16.
,, Haughton, pp. 497*a*, 504.
,, Gurlt, p. 22.
,, Selenka, p. 113, No. 39.
,, Watson, p. 85 ; Carlsson, p. 18.
Coraco-brachialis brevis (I. Portion). De Man, p. 106.
Sub-coraco-scapularis (*Pars scapularis interna* + *externa*) = *Subscapularis internus et externus.* Fürbringer.

" Der Subscapularis ist in seinem Ursprungstheil vom unteren Rande des Scapulo-humeralis posterior durch die Insertion der Pars

developed in the present subject. It arises from the anterior and outer half of the bone, including the margin between the superior and inferior surfaces. Its fibres rapidly converge as they pass towards the head of the corresponding humerus, and just before reaching that bone they become converted into a small, though strong, subcylindrical tendon, which is inserted on top of the ulnar tuberosity close to the combined tendons of the *coraco-brachialis*, and the *teres minor*.

The flat tendon of the *thoraco-scapularis* divides the

anterior M. serrati superf. getrennt. Dieser Theil und der Scapul. humeral. post. liegen dorsal, der Subcoracoideus ventral vom Subscapularis.

"Der ganze Muskel besteht nach Rüdinger's deutlicher Beschreibung aus zwei durch die Pars anterior M. serrati superficialis getrennten Abtheilungen, von denen die obere (*Subscap. extern.*) vom lateralen Rande des Schulterblattes, die untere (*Subscap. intern.*) von der ventralen Fläche der Scapula entspringt. Vereinigt ziehen beide um den hinteren unteren Theil des Schultergelenkes herum und heften sich mit einer kurzen Sehne an den unteren hinteren Theil des Tuberculum mediale s. minus humeri, nahe an dem Ansatzpunkte der Gelenkkapsel. Während dieser Muskel aus der Fossa axillaris heraustritt, nimmt er ein accessorisches kleines Bündel vom Os coracoideum auf.

"Die speciellen Verhältnisse sind folgende.

"I. Der obere Theil (*Subscapul. externus*) ist gewöhnlich der kleinere und entspringt bei *Haliaëtos*, *Columba*, *Psittacus*, *Corvus*, *Garrulus* vom zweiten Fünftel, bei *Buteo* vom ersten Drittel, bei *Falco tinnunculus*, bei *Ardea*, *Anser* und bei den meisten Wasservögeln von der basalen Hälfte des lateralen oder vorderen Randes der Scapula, greift auch auf deren Aussen-, oder auf die Innenfläche über. Bei *Fulica atra* ist der Ursprung auf das erste Viertel, bei Sphenisciden und Hühnern auf das erste Fünftel oder noch mehr beschränkt.

"II. Der untere, grössere Theil (*Subscapul. internus*) reicht vom oberen Theile des Coracoids an gewöhnlich auf die erste Hälfte (*Haliaëtos*, *Corvus*, *Columba*, *Leptoptilus*), oder auf die ersten zwei Drittel (*Buteo*, *Falco*)."

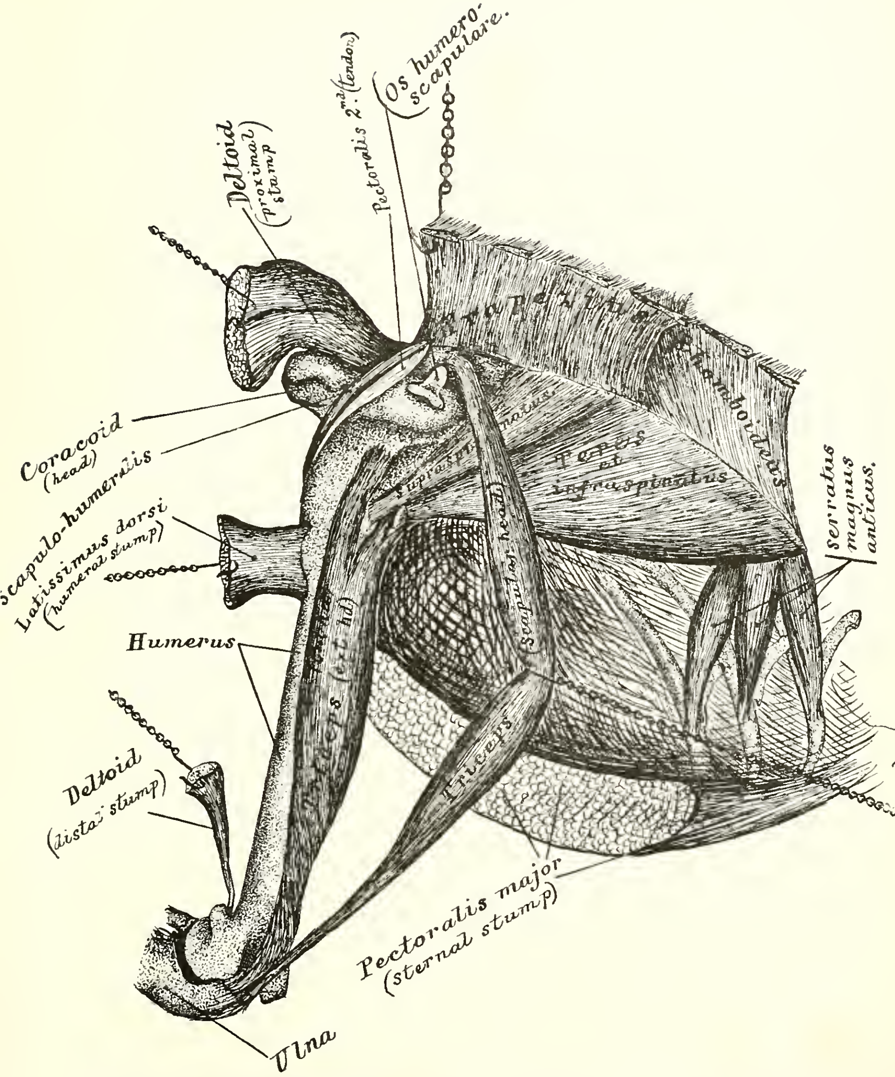

FIG. 34.—Oblique left lateral view of the second layer of muscles of the upper extremity, being those of the dorsum and arm, of a Raven. The heads of the ribs have been disarticulated from the vertebræ, and the latter drawn up with a dissecting hook and chain, the better to show the *trapezius* and *rhomboideus* muscles. The *os humero-scapulāre* has been entirely freed of both the deltoid and ligamentous attachment, though left in exactly its normal position in this bird. Life-size, by the author, from his own dissections.

posterior moiety of the belly of this muscle into two portions, covered by separate sheaths of fascia, but in the smaller and anterior division the fibres again come together and are included in the same sheath.

In the Apteryx this muscle has very much the same origin and insertion that it has in the Raven. According to Mivart it "is generally in Mammals much as it is in the human subject. It may be considerably smaller, however (as in Cetaceans); and by a singular exception it may (as in the Echidna) exclusively arise from the external surface of the scapula" (*Elem. Anat.*, p. 326).

The subscapularis is a powerful rotary muscle of the head of the humerus, and also an important auxiliary in retaining that bone in its shallow facet, and preventing displacement.

66. *The serratus parvus anticus*[1] is a thin, flat muscle covering the outer parietes of the chest. It arises by three rather extensive digitations from the outer surfaces of the first free rib, and the next two succeeding ones that connect with the sternum, above the origins of the *serratus magnus anticus* and the *thoraco-scapularis*. The fibres in a flat sheet of fascia pass upwards and backwards, to become inserted in the inferior margin of the corresponding scapula, along a line to the outer side of the insertion of the rhomboideus, as indicated in Fig. 8. In the Penguins this is the largest of the muscles of the scapula.

In the Raven at least, the *levator scapulæ*, the *serratus parvus anticus*, and the *serratus magnus anticus*, all really belong to the same system or series,

[1] See footnotes and synonymy under muscles described in the present work as the *serratus magnus anticus* and the *thoraco-scapularis* (Nos. 59 and 64).

which among most Mammals is known as the *serratus magnus* muscle. In certain Reptiles, as the Chameleon, it may be in several detached parts, whereas in Menopoma it is of a very diminutive size.

THE TENSOR PATAGII MUSCLES.[1]

67. The tensor patagii longus. 68. The tensor patagii brevis.

Under this head I will separately describe two extraordinary little muscles peculiar to the musculature of the pectoral extremity of the vast majority of birds.

[1] Referring to Bronn's *Klassen des Thier-Reichs* (vi. Band, pp. 253, 254) we find a very clear and succinct account of these muscles by Gadow, who records the following synonymy for them ; they being by him both described under

"77. M. PROPATAGIALIS.

Le grand (et le petit) extenseur de la membrane externe de l'aile. Vicq d'Azyr, 1773, p. 568, No. 3 und 4.

Langarmiger Muskel. Merrem, p. 156.

Tensor membranæ anterioris alæ. Wiedemann, p. 85 ; Tiedemann, § 267 ; Heusinger, p. 185, No. 19.

Spanner der vorderen Flughaut. Meckel, pp. 337–345.

Spanner des Windfangs. Prechtl, § 69.

Langer Muskel der vorderen Flügelfalte. Schöpss, p. 82, No. 2.

Kurzer ,, ,, ,, ,, ,, p. 86, No. 3.

M. accessorius ad bicipitem. Nitzsch.

Tensor longus + et brevis (patag. membran. anter. alæ). Selenka, No. 48 und 49.

Tensor patagii longus + brevis. De Man, p. 110, No. 15 und 16 ; Garrod, *Liter.*, No. 56 ; *Proc. Zool. Soc.* 1876, pp. 508–512, und Taf. 48–51 ; Forbes, *Tubinares*, pp. 25–28, und Taf. iv., mit ausgezeichneten Abbildungen ; Carlsson, pp. 20 und 21.

Tensor patagii longus. Watson, p. 88.

Tenseur marginal de la membrane antérieure de l'aile. Gervais et Alix, p. 23.

Cléido-metacarpien = Tenseur marginal. Alix, p. 402, No. 1.

Cléido-épicondylien = Tenseur moyen. Alix, p. 403, No. 2.

M. propatagialis. Fürbringer."

They have been noticed by every anatomist who has at any time interested himself with the morphology of the group, while the lamented Garrod successfully pointed out the fact as to how they might be used, and really were valuable factors in taxonomy. In the *Collected Scientific Papers* of this last authority we find them alluded to in the following words, viz.:—"In the triangular patagium of the wing of the bird the tendons of two muscles are to be found. One is that of the *tensor patagii longus*, which forms the supporting cord of the free margin of the membrane itself. The second is that of the *tensor patagii brevis*, which courses parallel with the humerus, not distant from that bone, to the muscles and fasciæ of the forearm." Professor Garrod follows these remarks by a full and clear description of the peculiarities of these muscles in the vast number (200±) of birds which he had especially dissected and examined in relation to this particular structure.

His highly valuable contributions are rather too long to incorporate in the present connection, but they will be found in the *Proceedings of the Zoological Society of London* for 1877 (pp. 506–19) and in that rare and imperishable work, his *Collected Scientific Papers*, edited by the late Mr. W. A. Forbes, another labourer in the same field, whose loss to us it is hard to overestimate.

Professor Owen's account of these fleshy slips runs thus:—

"A remarkable muscle, partly analogous in its origin to the clavicular portion of the deltoid, but differently inserted, is the *extensor plicæ alaris*, and forms one of the most powerful flexors of the cubit. It is divided into two portions, of which the anterior and shorter arises from the internal tuberosity of the

humerus; the posterior and longer from the clavicular extremity of the coracoid bone. In the Ostrich and Rhea, however, both portions arise from the coracoid. The

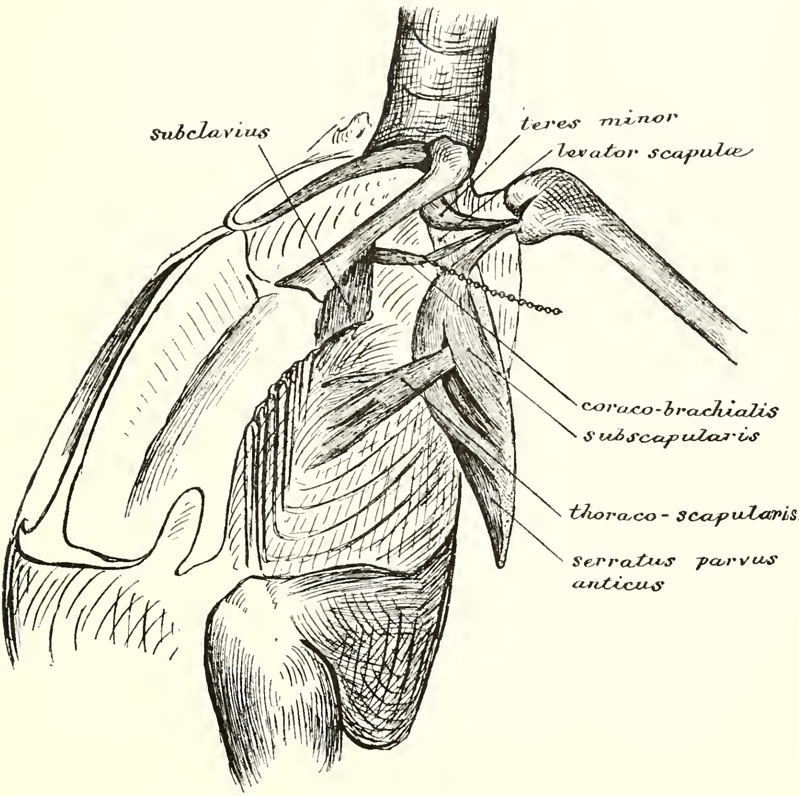

Fig. 35.—Left oblique view of the body of a Raven, dissected to show the deep muscles about the shoulder-joint. The coraco-brachialis has been pulled out by a hook and chain, and the scapula has been rotated outwards to show the muscles beneath. Other parts have also been placed in a favourable position to expose the muscles to be shown; somewhat diagrammatic. Reduced one-third, from dissections by the author.

posterior muscle sends down a long and thin tendon which runs parallel with the humerus, and is inserted, generally by a bifurcate extremity, into both radius and

ulna. The anterior muscle terminates in a small tendon which runs along the edge of the aponeurotic expansion of the wing. In this situation it becomes elastic; it then resumes its ordinary tendinous structure, passes over the end of the radius, and is inserted into the short confluent metacarpal. It combines with the preceding muscle in bending the forearm; and further, in consequence of the elasticity of its tendon, puckers up the soft part of the fold of the wing" (*Anat. Verts.*, vol. ii. p. 98).

And Mivart says, when speaking of the trapezius, that in Bats a long slender segment of this muscle may pass along the upper margin of the wing membrane from the occiput to the distal phalanx of the pollex.

"In the Flying Squirrel (*Pteryomys*) a similar muscular band goes to the rudimentary pollex, but it springs from the zygoma, and is therefore rather a modification of the platysma myoides than of the trapezius; as it is also in *Galeopithecus*.

"In birds an analogous and similarly slender muscle goes to the pollex or to a sesamoid at its base, but this muscle is often an offshoot from the pectoralis major, though it may contain fibres from the deltoid or from the biceps—showing in what diverse ways a similar want may be supplied" (*Elem. Anat.*, p. 320).

I present the results of the observations of these several eminent authorities, more particularly to show how very different are the relations, origins, and insertions of these two little muscles in the class birds, and how well accurately recorded dissections of them would repay the labours of the investigator. Several years ago I showed how the distal extremity of the *tensor patagii longus* was attached to the *os prominens*

in many of our American Hawks and Owls (*Bull. Nutt. Ornitho. Club*, vol. vi. No. 4, October, 1881). I also showed how among these latter birds, when the wing was extended the tendon of the *tensor patagii longus* raised the *os prominens*, and thereby increased the extent of the alar superficies (*loc. cit.*, p. 200). In foregoing paragraphs of the present work, I have already described the dermo-tensor patagii muscle, and how it acts as an auxiliary to the tensor patagii longus.

Before entering upon our detailed descriptions of the *tensor patagii* muscles, I desire to say a word here as to how they are best studied in general. This I do from the fact that in the future there will no doubt be many dissections made of these muscles, as they have been proven to be of no little classificatory value in birds, as I have already remarked.

First, it may be as well to add, that in certain birds another small muscle occurs in this region; it has been described as the *bicipital slip to the patagium* (Figs. 35 *bis* and 35 *ter*, *B. slip*). This is a fleshy fasciculus of muscle that is differentiated off from the anterior surface of the *biceps*, and passing between the cutaneous folds of the patagium becomes inserted into the tendon of the *tensor patagii longus* at about the middle of its course.

Garrod states that "the presence or absence of this muscular fasciculus is a very constant character among closely allied birds." He not only found it in the Caprimulgi, but also in Plovers, Cranes, Gulls, Auks, and some few other groups. It is absent in the *Corvidæ*. In Fig. 35 *ter*, I present its appearance as it occurs in our Mourning Dove, a bird I especially dissected to show it as an illustration in the present connection.

Professor T. Jeffery Parker describes this muscle for the Common Pigeon (*Zootomy*, p. 251) as the *tensor patagii accessorius*, and says, "Its anterior border is

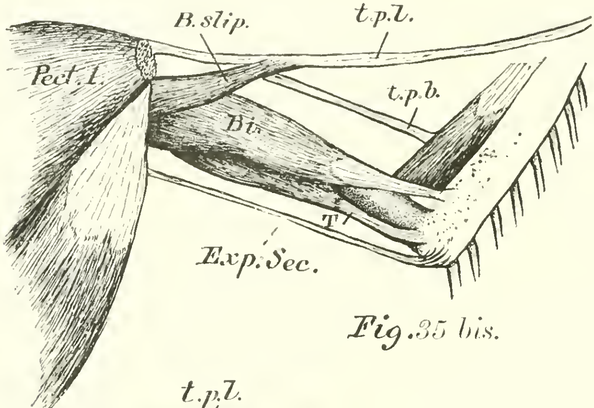

Fig. 35 bis.

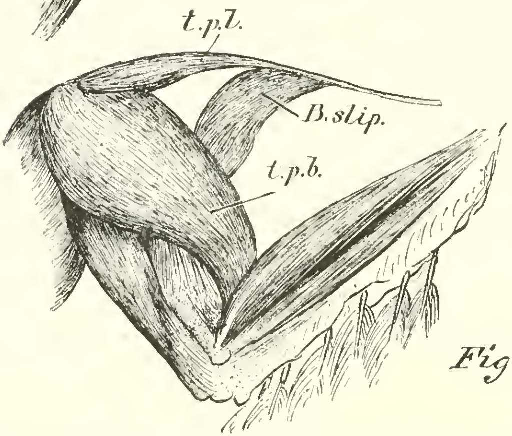

Fig. 35 ter.

FIG. 35 *bis*.—Axillary muscles of the side of *Gallinula chloropus*. By the author, after Garrod. *Exp. Sec.*, expansor secundariorum; *Pect.* 1., great pectoral muscle; *B. slip*, biceps slip; *Bi*, biceps; *T*, triceps; and other letters as in former figures.

FIG. 35 *ter*.—Outer aspect of the axillary muscles of the right arm in a specimen of the Mourning Dove (*Zenaidura macroura*). From the specimen, by the author, and after his own dissections. Letters as before.

connected by fascia with the tendon of the tensor longus, and from its posterior border a long stout tendon is given off which passes outwards, soon becoming parallel

to the tendon of the tensor longus, and having a common insertion with it."

If this last tendon be present in our wild pigeons, it is very feebly developed and consequently easily overlooked. I did not detect it in the Dove above alluded to, and must believe it was absent in that particular specimen. Wherever I examined it, it has invariably agreed with Garrod's description of it.

Now what I have said above in reference to the dissection of these muscles in the Raven, applies with equal truth to any bird. Let us choose for our purpose an oriole, for instance, and in that species the *tensor patagii longus*, *tensor patagii brevis* and *dermo-tensor patagii* all occur. Having secured a good specimen of some such bird, pluck it perfectly clean, being careful, in removing the feathers of the wings, that you do not tear the skin (Fig. 35 *quat.*). Now with a small, sharp dissecting scalpel make an incision just through the integuments and no more, along the line which I have indicated by the letters *inc.* in Fig. 35 *quat.*, and then carefully and completely reflect this skin-flap in both directions until all the superficial muscles of the arm and forearm are exposed, even to the tendon which extends from the shoulder to the wrist (*tp. l.*), in the free margin of the duplicature of the skin in which these muscles are found.

By practice we soon learn the best way of doing this, and in the case of all ordinary sized birds, our left hand soon learns how to hold the wing in such a way that the parts to be examined are kept on the stretch, thus facilitating our examinations and study, which latter may now be undertaken.

Professor Garrod chose the wing of *Icterus vulgaris* to illustrate the arrangement of the patagial muscles in the *Passeres*, and it will be seen by an examination of his

figure given below (Fig. 35 *quin.*) that he found in that species the tendon of the *dermo-tensor patagii* merging

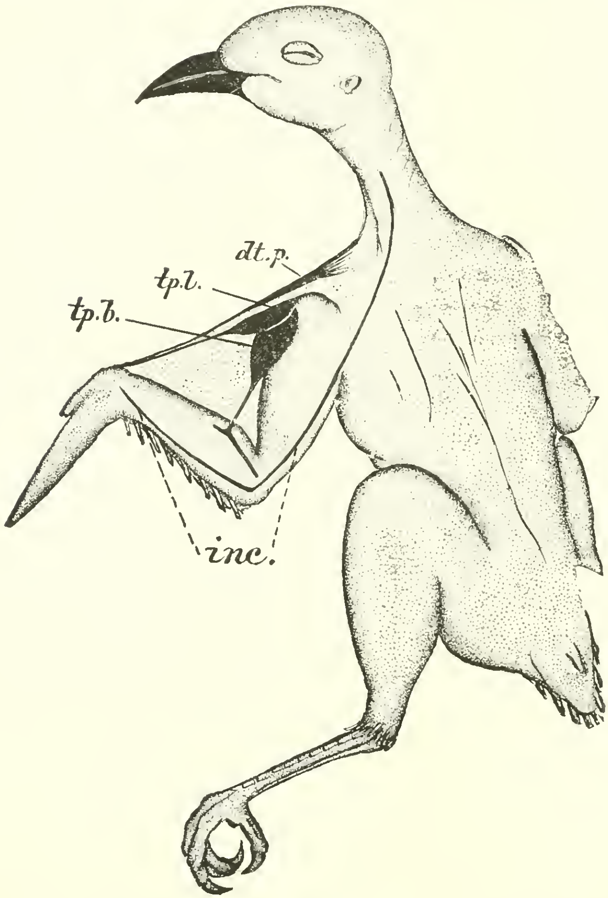

FIG. 35 *quat.*—The plucked body of a medium sized passerine bird, with its pterylosis not shown, but with the *patagial muscles* of the arm in black, and supposed to be seen through the skin ; *dt. p.*, dermo-tensor patagii ; *tp. l.*, tensor patagii longus ; and *tp. b.*, the tensor patagii brevis ; *inc.*, the line of incision to be made in order to expose them for examination. Drawn by the author.

with the tendon of the *tensor patagii longus*, near the shoulder-joint, much in the same way as the present

writer found it to exist in the Raven and other *Corvidæ*. In this connection the reader should refer back to the account of the *dermo-tensor patagii* in the present work (No. 6).

We would naturally expect this to be the case, as *Icterus* and the Raven are members of nearly related families.

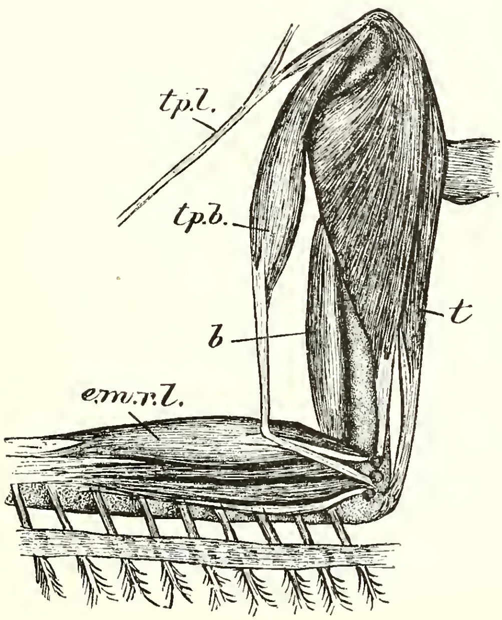

FIG. 35 *quin.*—View, from the outer side, of the muscles of the patagium of the left wing of a passerine bird. Troupial (*Icterus vulgaris*). (After Garrod.)

Among some other passerine birds, however, the tendons of the two muscles just mentioned do not blend with each other in the manner we have described, but remain quite distinct as far as the carpus. This is the case in our Purple Martin (*Progne subis*), as I have shown in Fig. 35 *sex.*

Some of the most complicated and interesting conditions assumed by these muscles are to be seen among such groups of sea-fowl as the *Tubinares*, and Forbes presented us with drawings and descriptions of many of these in his contributions to the *Proceedings of the Zoological Society of London.*

Now in the Raven we find a still different con-

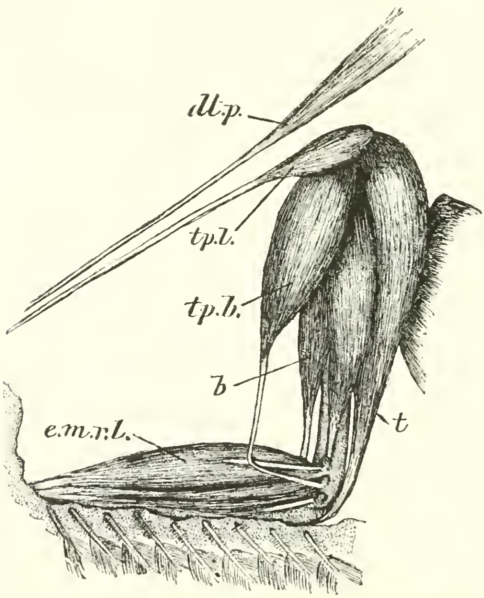

FIG 35 *sex.*—Same view and corresponding parts of the same wing of a passerine bird, Purple Martin, *Progne subis* (by the present writer). *tp. l.*, tensor patagii longus; *tp. b.*, tensor patagii brevis; *dt. p.*, dermo-tensor patagii; *e.m.r.l.*, extensor metacarpi radialis longus; *t.*, triceps; *b.*, biceps; *S. R.*, secondary remiges. (Nearly × 2.)

dition of affairs from some of those alluded to above, in the arrangement of these two little muscles and their tendons, so far as their origins and insertions are concerned, which I will proceed now to describe.

67. *The tensor patagii longus* (Figs. 8, 26, 32, and

33) muscle arises by a tendon common to it and the *tensor patagii brevis* from the supero-mesial line of the head of the corresponding clavicle. This tendon is flat and thin, being closely approximated to the head of the coracoid and the outer angle of the *pectoralis major* muscle. The *tensor patagii longus* soon becomes muscular, however, after leaving its origin, to form a slender, spindle-shaped belly about 3·5 centimetres long. From its distal apex then a tendon is given off, which runs in the marginal duplicature of the patagium, and with which fibro-elastic membrane it is intimately connected. This tendon increases in calibre, and for more than its entire middle third it becomes in turn of a fibro-elastic structure. Finally passing over the end of the radius and to the inner side of the tendon of the *extensor metacarpi radialis longus*, it is attached to the *os radiale* of the carpus, and the fascia which binds down the other tendons on the anterior aspect of the wrist-joint.

68. *The tensor patagii brevis* arises from the head of the clavicle, as described for the last muscle, by a common tendon. The muscular portion of this short tensor of the patagium is very considerably broader and longer than that of the long tensor of the membrane in question. It also overlies the former to a certain extent near their common origin, and is pointed downward towards the elbow instead of outwards towards the carpus. Its tendon is straight, slender, and nearly of uniform calibre. At about 1·5 centimetres from the distal end of the humerus it meets the *extensor metacarpi radialis longus* muscle of the antibrachium. There its tendon bifurcates, and the shorter and distal-projecting bifurcation is soon merged into the fascia of the muscle just alluded to, of the

forearm; while its longer and more tendon-like fork runs back with the tendon of the *extensor metacarpi radialis longus*, to become inserted just *below* the tubercle of the external condyle of the humerus, the insertion of the extensor itself monopolizing the *outer* aspect of the tubercle in question (Fig. 33).

The action of these muscles is well described in the quotations of the several eminent authorities I have incorporated with my own descriptions above.

MUSCLES OF THE BRACHIUM.

We come now to take up those muscles of the upper extremity which more properly belong to the humeral region, and are in most instances inserted into the bones of the forearm. Under this division of the muscles of the upper extremity, I will notice the following:—

69. The biceps,
70. The deltoid.
71. The triceps.
72. The brachialis anticus.

69. *The biceps*[1] is a large and powerfully developed muscle in the Raven. To study it satisfactorily we

[1] For further and important studies of the *biceps* muscle in birds, see Gadow (*loc. cit.*, p. 261), who records the subjoined synonymy:—

"79. M. BICEPS BRACHII.

Le biceps. Vicq d'Azyr, 1773, p. 570; Cuvier.
Zusammenleger des Flügels. Merrem, p. 155, No. 3.
Zweiköpfiger Armmuskel. Wiedemann; Prechtl, § 46.
Biceps. Tiedemann, § 258; Heusinger, p. 184.
,, Meckel, *System*, p. 322; d'Alton, p. 22.
,, Rüdinger, p. 99; Selenka, p. 124, No. 51; De Man, p. 111.
,, Fürbringer; Carlsson, p. 26.
Biceps brachial. Gervais et Alix; Watson, p. 102; Alix, p. 405.
Flexor antibrachii longus s. biceps brachii. Schöpss, p. 135, No. 24."

Gadow divides the muscle into two parts—I. *m. biceps brachii*, and II. *pars propatagialis* (compare footnotes under the account of the tensor patagial muscles of the present work).

must carefully remove the common integuments of the arm and proximal moiety of the forearm; divide the tendons of the patagii muscles; and dissect away all the superfluous adipose tissue, fascia and vessels. The biceps will then be seen to be a large subfusiform muscle, occupying the anterior aspect of the arm. Its proximal third is composed of a broad, flat tendon covering the top of the shoulder-joint. This portion is divided into two heads, the aperture of the division being a wide obtuse angle, with its apex opposite the humeral head. This bifurcation gives rise to the *long* and *short heads* of the *biceps*, the former being inserted into the outer aspect of the head of the coracoid just beyond the glenoid cavity, while the short head is attached to the distal angle of the ulnar tuberosity of the humerus (Figs. 24, 28, 29, and 32). This flat, proximal tendon extends somewhat beyond the bifurcation, but soon is usurped by the commencement of the carneous portion of the muscle, which is correspondingly broad and subcompressed. After forming the muscular belly, the fibres as they pass down rapidly converge to an apex, and finally form the strong cord-like tendon for insertion, which passes to the ulna and is attached to that bone, immediately in front of the articular cavity for the trochlear surfaces of the distal extremity of the humerus.

The biceps is a powerful flexor of the forearm, and this is its chief function.

70. *The deltoid*[1] is partially divided into two portions; one long narrow head arises tendinous from

[1] A very excellent account of the *deltoid* muscle in birds is also given us by Gadow (*loc. cit.*, p. 230), together with a synonymy which is herewith republished :—

the clavicular process of the scapula and from the contiguous surface of the clavicle itself (Fig. 33). These fibres wind round the back of the shoulder-joint, and are joined by the fibres that arise upon the entire outer surface of the large *os humero-scapulare*. These latter are inserted upon an extensive area upon the anconal aspect of the bone, beyond the humeral articular head, and down nearly the entire length of the shaft below it, making room for the latissimus dorsi at the point where it is inserted. The first-mentioned division of the muscle does not enter apparently into this part of the insertion, but becomes more intimately blended with the bulk of the muscle as the rapidly converging fibres proceed down the humeral shaft, until both blend to form a strong and distinct subcylindrical tendon, which is inserted into the proximal side of the tubercle of the external condyle, and above the insertion of the *extensor metacarpi radialis longus* muscle of the antibrachium.

"69. M. DELTOIDEUS MAJOR.

Le grand releveur de l'humerus. Vicq d'Azyr.
Achselheber. Merrem, p. 154, No. 14.
Le deltoide. Cuvier.
Aeusserer Oberarmstrecker. Wiedemann.
Deltoides. Meckel, *System*, p. 310, No. 1.
Deltoideus major + minor. Tiedemann, §§ 253, 254.
Deltoideus major. Rüdinger; Heusinger, p. 183.
,, ,, Selenka, p. 116, No. 42.
,, ,, De Man, p. 107 ; Carlsson, p. 20.
,, ,, Fürbringer, *Morph. Jahrb.*, xi.
Deltoideus superior. Schöpss, p. 117, No. 18.
Grosser deltaförmiger Muskel. Prechtl, § 36.
Deltoid. Forbes, *Tubinares*, p. 30.
Deltoideus s. axillaris. Fürbringer, *Morph. Jahrb.*, v.
Deltoide postérieur. Gervais et Alix, p. 23.
Sous-épineux et deltoide postérieur. Alix, p. 394–96.
Tensor patagii longus (*superficialis* part.). Watson, p. 88."

For nearly its entire length the deltoid is intimately attached to the triceps by fascia, more especially to its long head, where it comes in contact with that slip of the former which passes round the shoulder-joint.

71. *The triceps*[1] muscle in the Raven is divided into three portions, an *internal* and *external* head, and a *long* or *scapular* head, but so loosely attached is the latter to the remaining two heads of the triceps, that it almost amounts to two muscles in this bird.

The long or scapular head arises, somewhat tendinous,

[1] Agreeing with what I found in my dissections upon *Corvus*, three years ago, Gadow has also declared that "Der Triceps brachialis besteht bei den meisten Vögeln aus drei in der Regel von einander getrennt bleibenden Theilen, namlich eine P. scapuli-cubitalis und 2 P. humero-cubitales (ext. et intern.)" (*loc. cit.*, pp. 263, 264). He gives the following synonymy, to wit:—

"81. M. TRICEPS CUBITI S. ANCONÆUS.

Le grand extenseur du coude. Vicq d'Azyr, p. 571.

Extenseur de l'avant bras. Cuvier.

Ohne Namen. Merrem, p. 155, No. 1 und 2.

Lange äusserer und innerer Ellenbogenmuskel. Wiedemann, pp. 86–89.

Anconæus longus, brevis et brevissimus. Tiedemann, §§ 264, 265 266.

Der lange, kurze und kleinste Ellenbogenknorrenmuskel (*Anconæus longus, brevis et quartus*). Heusinger, p. 185, No. 16, 17, 18.

Strecker des Vordearmes. Meckel, p. 331, No. 9.

" " " Schöpss, p. 190, No. 23.

Langer, kürzerer, und kleinster Strecker. Prechtl, §§ 43, 44, 45.

Triceps extensor cubiti et anconeus. Reid, p. 142.

Triceps brachii. Selenka, p. 126, No. 53.

" " De Man, No. 19.

" " Forbes (*Tubinares*), p. 30; Carlsson, p. 21.

Triceps extensor cubiti. Watson, p. 90.

La longue portion du triceps brachial, le vaste externe et le vaste interne. Gervais et Alix, pp. 25 und 26.

Triceps brachial. Alix, p. 404.

Anconeus (*scapularis* + *coracoideus*). Fürbringer, *Morph. Jahrb.*, xi."

from the superior aspect of the scapula, upon a circumscribed area just posterior to the glenoid cavity (Fig. 24); the fibres form a rather thick, flattened muscle, which, winding round the shoulder-joint, beneath the deltoid, and parallel to the fibres of the scapular head of that muscle, becomes feebly blended with those of the external head of the triceps, as they together pass down on the postero-lateral aspect of the humeral shaft. The connection of this part of the muscle along its course, in this locality, with the other heads of the triceps, is most intimate through the closely binding fascia, rather than through any blending that takes place among the fibres of the several portions.

Just above the elbow, the fibres of the scapular head of the triceps converge and merge into a strong cord-like though flattened tendon, which passes to the radial side of the olecranon process of the ulna to become inserted there, near its base.

The *internal* and *external heads* of the *triceps* are intimately blended except at their proximal extremities. In this last situation they form a well-marked bifurcation, where each arises from the anconal surface of the shaft of the humerus; the internal head towards the deltoid attachment, and the external head running into the pneumatic fossa. Between the limbs of the muscular bifurcation thus formed arises the *supraspinatus* muscle. The external head of the triceps in this locality also of itself bifurcates in order to allow the *teres et infraspinatus* muscle to attach itself to the humeral shaft (Fig. 27).

The internal and external heads of the triceps become blended in their attachment down the anconal aspect of the bone to a point below the insertion of the deltoid. Here they form a flat tendon, partly muscular, which is quite broad, and that passes over the elbow-joint to

insert itself into the entire under surface of the olecranon process of the ulna.

The *triceps* is the great extensor of the antibrachium, and direct antagonist of the *brachialis anticus* and *biceps*. Its scapula or long head also materially protects that part of the shoulder-joint over which it passes,

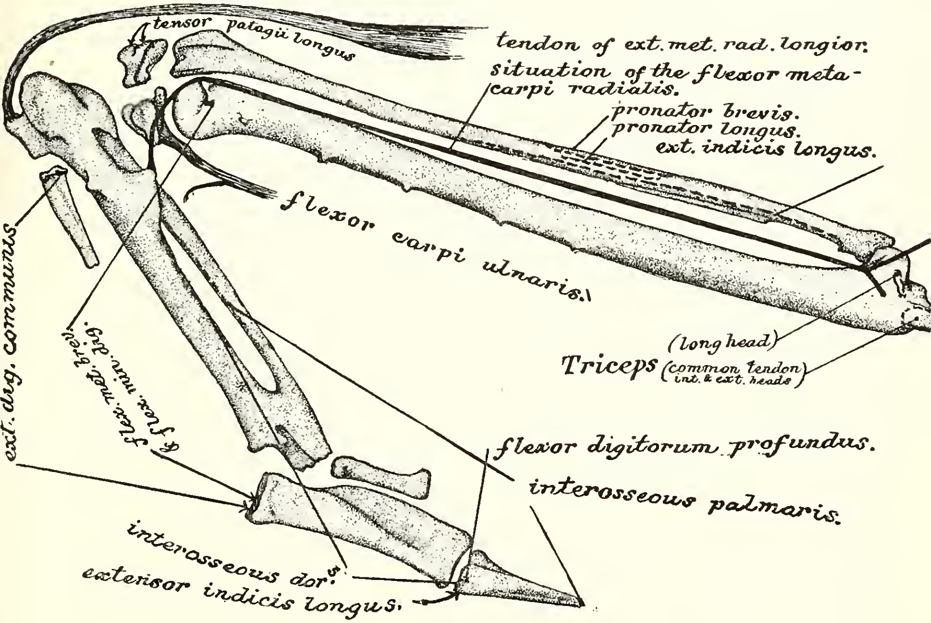

FIG. 36.—Bones of the forearm and hand of a Raven ; palmar aspect, and slightly dislodged from their normal positions in order the better to show the origins and insertions of muscles for which the drawing is designed. Life-size, by the author, from a specimen in his own collection.

and assists other muscles of that region in retaining the humerus in its shallow socket.

72. *The brachialis anticus* is a very well-defined and neat little muscle in the Raven (Figs. 24, 29, and 37). It arises almost entirely fleshy from a circumscribed area on the inner side of the anconal aspect of the distal extremity

of the humerus, its fibres passing directly over the elbow-joint on that side to insert themselves upon the lateral surface of the proximal end of the ulna quite up to the margin of the greater sigmoid cavity.

This muscle protects the anterior aspect of the elbow-joint, and assists the *biceps* in flexing the antibrachium upon the brachium.[1]

MUSCLES OF THE FOREARM AND HAND.

As we pass towards the hand in a bird, and this Raven forms no exception, we find the muscles deviating still more from the musculature of the corresponding parts among the Mammalia. Muscles arise and tendons depart from their more common tracks to be inserted as best meets the main function of this limb in Aves—its modification to an instrument for the purposes of flight. Many of these muscles I can make out, but quite a number of them are not noticed by Owen, Huxley, Mivart, Garrod,

[1] Fürbringer describes this muscle as the *brachialis inferior*, and in this he was followed by Gadow, who retained the same name for it, and in Bronn's *Klassen* presents the following synonymy (*loc. cit.*, p. 262) :—

"80. M. BRACHIALIS INFERIOR.

Le court fléchisseur de l'avant bras. Vicq d'Azyr, p. 572.
,, ,, ,, ,, ,, ,, Gervais et Alix, p. 27.
Ellenbogenbeuger (*Flexor parvus ulnæ*). Wiedemann, p. 89.
Brachialis internus. Tiedemann, p. 312, No. 2.
,, ,, d'Alton, p. 25, No. 23.
,, ,, Rüdinger, p. 100 ; Heusinger, p. 184, No. 11.
,, ,, Selenka, p. 125, No. 52.
,, ,, De Man, No. 18.
,, ,, Watson, p. 91.
,, ,, Carlsson, p. 27.
Kleiner Beuger. Meckel, p. 325, No. 2.
Kurzer Beuger des Vorderarmes. Schöpss, p. 141, No. 28 (*Flexor brevis antibrachii*).
Innerer Armmuskel (Einzieher des Vorderarmes). Prechtl, § 47.
Brachialis inferior. Fürbringer."

or Forbes, and in the absence of the works of other authors I shall be obliged to name them as best I may, and as the functions they perform seem to indicate.

I must believe that if Mr. Garrod had paid as much attention to certain groups of the muscles of the arm, forearm, and pinion in birds, as he did to certain restricted groups of muscles of the lower extremity, he would have discovered characters of value in classification fully as significant as those he so ably elucidated in the latter region. His excellent observations upon the methods of origin and insertion of the *tensor patagii brevis* point most emphatically to that fact. As I have so often repeated elsewhere, we may say as we please, but the classification of animals will only be placed beyond all doubt when *their entire morphology is known and correctly comprehended, and duly utilized.*

In the freshly plucked wing of a Raven we notice how very prominent the muscles of the forearm and pinion are, more particularly the tendons and muscles upon the inner aspect of the forearm. In this locality, it will be seen, as in the case of the tendon of the *extensor metacarpi radialis longior*, that they are almost completely ensheathed in the common integuments, so prominently do they stand out. In removing the skin, we discover a strong fibro-elastic cord, which passes from the under side of the proximal end of the ulna, and joins each and every quill of the row of large feathers of the wing, at a distance of about a centimetre or less, all the way to the distal apex of the pinion, towards which it gradually converges, and where it is finally attached. This semitendinous cord plays the part, to a certain degree, of an antagonistic tendon to the tendon of the *tensor patagii longus*, it being by no means an inefficient flexor to the pinion upon the forearm, and in closing the wing draws the hand towards the

antibrachium. This tensor of the posterior patagium, of course, is covered by the folding of that membrane, much in the same way as the tendon of the *tensor patagii longus* is.

The forearm of the Raven presents us with the following muscles for our examination, viz. :—

73. The extensor metacarpi radialis longior.
74. The extensor digitorum communis.
75. The supinator brevis.
76. The flexor metacarpi radialis.
77. The pronator brevis.
78. The pronator longus.
79. The extensor ossis metacarpi pollicis.
80. The anconeus.
81. The extensor indicis longus.
81*a*. The flexor digitorum sublimis.
82. The flexor digitorum profundus.
83. The flexor carpi ulnaris.
84. The flexor carpi ulnaris brevior.

73. *The extensor metacarpi radialis longior*[1] (or *longus* as it is occasionally written) is one of the, if not

[1] This important muscle Prof. Gadow has termed the *extensor metacarpi ulnaris* (which is probably a misprint, and should be *radialis*). He gives its synonymy (*loc. cit.*, pp. 274, 275) as follows :—

"88. M. EXTENSOR METACARPI ULNARIS [RADIALIS ?].

Le long radial. Vicq d'Azyr, 1773, p. 575, No. 1.
Le radial. Cuvier.
Hinterer äusserer Handspanner. Merrem, p. 156.
Mittelhandstrecker. Wiedemann, p. 90.
Extensor metacarpi radialis longus. Tiedemann, § 268.
(Langer Speichen-Mittelhandstrecker.) Heusinger, p. 187, No. 22 + No. 21.
,, ,, ,, Schöpss, 145, No. 31.
Extensor metacarpi radialis longus. Selenka, p. 130, No. 59.
(Langer Speichen-Mittelhandstrecker.) Carlsson, p. 22.
,, ,, ,, De Man, No. 23.
,, ,, ,, Watson, p. 94.
Langer Speichenstrecker. Meckel, p. 333, No. 1.
Langer Mittelhandstrecker. Prechtl, § 52.
Extensor metacarpi longus. d'Alton, p. 27, No. 28.

the, principal extensor of the hand upon the forearm. It arises by two strong tendinous heads: the outer one from the tubercle of the external condyle of the humerus, just above the origin of the tendon of the *tensor patagii brevis;* and the inner and stronger one from a tubercle found above the oblique trochlear facet of the distal end of the same bone, for the radius. The median nerve passes between the two heads, after which they unite to form a large fusiform muscle, the highest of the group, seen on lateral aspect of the arm, which, running parallel with the ulna, becomes converted into a flat, broad, and strong tendon at about the middle of the forearm. This passes directly on to become inserted into the apex of the anchylosed first metacarpal of the carpo-metacarpus.

The attachment that the *tensor patagii brevis* makes with the present muscle has already been described above. The distal extremity of the radius is distinctly grooved in a longitudinal direction to admit of the lodgment of the tendon of the *extensor metacarpi radialis longior*, before it makes its final attachment. Owen says that this muscle "raises the hand, draws it forward toward the radial margin of the forearm, and retains it in the same plane. In the Penguin this muscle is extremely feeble, and the tendon is lost in that of the *tensor plicæ alaris.*"

74. *The extensor digitorum communis* [1] is a smaller muscle than the one just described, and arises from the

Le long supinateur. Gervais et Alix, p. 26.
" " " Alix, p. 408.
Extensor carpi radialis. Selenka, p. 129, No. 58; Carlsson, p. 22.
Extensor carpi radialis brevis. Selenka, p. 130, No. 59*a*."

[1] This is 92. M. EXTENSOR DIGITORUM COMMUNIS of Gadow (Bronn's *Klassen des Thier-Reichs*, vi. Band, p. 282) and of Selenka (*loc. cit.*, p. 131, No. 61).

humerus immediately below the tubercle of the external condyle. It soon forms a spindle-shaped muscle which blends with the *supinator brevis* as it passes it, and terminates in a strong, cord-like, glistening tendon at about the middle of the forearm. This tendon passes

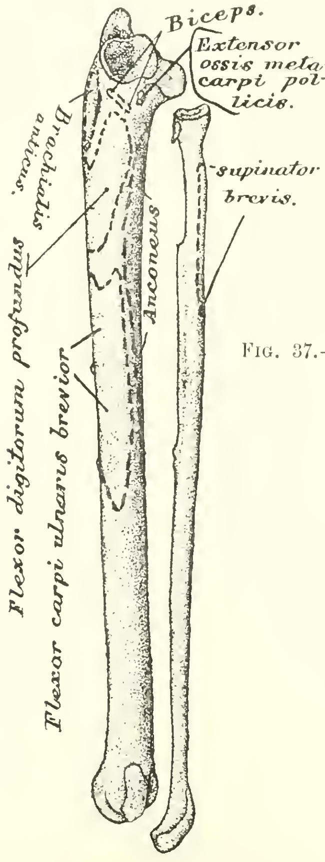

FIG. 37.—Radial aspect of left ulna and radius of an adult Raven, designed to show origin and insertion of muscles of the forearm. Life-size, by the author, from the specimen.

through a groove in common with the tendons of the *flexor carpi radialis* and the long extensor on the palmar side of the distal extremity of the ulna, and in passing down the front of the hand, first throws off a small tendon which is inserted on the outer side of the

base of the pollex digit; after which, it continues down the anterior aspect of the shaft of the carpo-metacarpus in a well-marked and somewhat oblique groove intended for it, as far as the upper end of the proximal phalanx of the middle digit. Here it lies beneath the tendons of the other muscles, when turning to the median line through a fibro-cartilaginous pulley intended for it, it is finally inserted at a mid-point upon the anterior rim of the proximal phalanx of the middle finger. Upon lateral aspect of the outer side of the muscles of the forearm, the *extensor digitorum communis* lies next below the *extensor metacarpi radialis longior*, occupying the middle of the group there found.

75. *The supinator brevis*[1] is exposed after removing the last-described muscle, to which it is rather closely attached by a tendinous connection. It arises from the external condyle of the humerus, below the origin of the tendon of the *extensor digitorum communis*, and passing directly in a nearly straight line to the radius it becomes attached to the outer side of the shaft of that bone for nearly one-third of its length. This muscle, here quite feebly represented, acts, as in

[1] "84. M. ECTEPICONDYLO-RADIALIS.

Le court supinateur. Vicq d'Azyr, p. 573.
" " " Cuvier.
" " " Gervais et Alix, p. 26; Alix, p. 407.
Anleger des Vorderarmes. Merrem, p. 155.
Aeusserer Speichenbeuger. Wiedemann, p. 90.
Supinator. Tiedemann, § 262.
" Schöpss, p. 140, No. 27.
Supinator brevis. Heusinger, p. 185, No. 14.
" " Selenka, p. 129, No. 57; De Man, No. 22.
" " Watson, p. 93; Carlsson, p. 23.
Rückwärtswender. Meckel, p. 330, No. 8 und No. 7.
Antagonist der Niederzieher. Prechtl, § 51." (Gadow in Bronn's *Klassen, loc. cit.*, p. 269.)

the limbs of other Vertebrata, as a supinator, and feeble antagonist to the powerful pronators to be described further on.

76. *The flexor metacarpi radialis*[1] is the lowest of the group of three muscles on the outer aspect of a Raven's forearm. Its mode of origin is very interesting, for we find it arises by two distinct tendinous heads, the longer one coming off from the external condyle of the humerus, where it overlaps the origin of the *supinator brevis*, while the shorter one arises from the ulna just without and rather beyond the base of the olecranon process. In common with the others of the group of muscles to which it belongs, it has a fusiform shape for the proximal moiety of the forearm, and is intimately attached for its middle third to the interosseous membrane.

Rather beyond the middle of the shaft of the ulna the

[1] Tiedemann used this name for the muscle here described, as will be noted from Gadow's synonymy (*loc. cit.*, p. 276):—

"89. M. EXTENSOR METACARPI ULNARIS.

Le long fléchisseur du métacarpe. Vicq d'Azyr, p. 575, No. 5.
Cubital interne. Cuvier.
Hinterer innerer Handspanner. Merrem, p. 156 (?).
Oberer oder langer Mittelhandbeuger. Wiedemann, p. 91.
Flexor metacarpi radialis. Tiedemann, § 271.
,, ,, ,, Heusinger, p. 188, No. 25.
Aeusserer Ellenbogenmuskel. Meckel, p. 335, No. 3.
Abductor metacarpi. Schöpss, p. 150, No. 33.
Langer Mittelhandbeuger. Prechtl, § 55.
Extensor carpi ulnaris. Selenka, p. 131, No. 60.
,, ,, ,, De Man, No. 24; Watson, p. 95; Carlsson, p. 23.
Le cubital postérieur. Gervais et Alix, p. 27.
,, ,, ,, Alix, p. 409."

[This muscle *flexes* the hand on the antibrachium, although it arises from the *external* condyle.—R. W. S.]

flexor metacarpi radialis tapers to a point, then merges into a strong, cord-like tendon, which passing through the fibrous sheath to the outer side of the distal end of the ulna, in common with the tendons of other muscles previously alluded to, it goes directly to the prominent process which juts from the proximal third of the posterior aspect of the shaft of mid-metacarpal, where it is firmly attached. This muscle, when brought fully into action, is a powerful flexor of the hand upon the antibrachium.

In the Ostrich this muscle arises from the lower third of the ulna, while in the Penguin it is entirely absent (Owen).

In Fig. 36 I have drawn the line occupied by the tendons of this muscle, as well as the line of its axis, which is supposed to be in the same straight line with its tendon of insertion.

77. *The pronator brevis*[1] is the uppermost of the

[1] Of the pronator group of muscles in birds, Gadow records the following synonymy (*loc. cit.*, pp. 266, 267) :—

"82. MM. ENTEPICONDYLO-ANTIBRACHIALES.

"A.—ENTEPICONDYLO-RADIALES.

"*I. Pronator sublimis s. brevis.*

Le muscle qui tient lieu du pronateur rond. Vicq d'Azyr.
Kurzer Speichenbeuger. Wiedemann, p. 89.
Pronator primus s. brevis. Tiedemann, § 260.
Beuger des Vorderarms. Meckel, p. 326.
Pronator brevis. Schöpss, p. 137, No. 25 ; d'Alton, p. 26 ; Rüdinger, p. 113 ; Selenka, p. 127, No. 54 ; Carlsson, p. 22.
Kurzer Niederzieher des Vorderarms. Prechtl, § 49.
Pronator sublimis. De Man, p. 112.
Pronator teres. Gervais et Alix ; Watson, p. 102.

"*II. Pronator profundus s. longus.*

Le radial externe. Vicq d'Azyr.
Langer Speichenbeuger. Wiedemann, p. 89.

pair of powerful pronators in the forearm of this bird. It arises by a tendon rather above the internal condyle of the humerus; the fibres, forming a thick fusiform muscle, pass obliquely across the interosseous space to become inserted on the ulnar side of the shaft of the radius, just beyond the junction of the proximal and middle thirds. This muscle is somewhat compressed

Pronator secundus s. longus. Tiedemann, § 261; Rüdinger, p. 113.
Beuger des Vorderarms. Meckel, p. 326.
Pronator longus. d'Alton, p. 26; Schöpss, p. 138, No. 26; Selenka, p. 128, No. 55.
Langer Niederzieher. Prechtl, § 50.
Rond pronateur profond. Alix.
Pronator profundus. De Man, p. 112.

" B.—ENTEPICONDYLO-ULNARIS.

Flexor brevis ulnæ. Wiedemann, p. 93.
" " " Tiedemann, § 263; Heusinger, p. 185, No. 15.
Ohne Namen. Meckel, p. 328, No. 5.
Flexor profundus interior gallinaceorum. Schöpss, p. 144, No. 30.
" " " " Selenka, p. 128, No. 56.
Kurzer Beuger der Elle. Prechtl, § 48.
Anconé interne. Alix, p. 408."

This synonymy is immediately followed by a concise description (in the same work) of the pronators, they agreeing substantially with my *pronator brevis* and *longus* (Nos. 77 and 78) respectively. Then comes a description of Prof. Gadow's *m. entepicondylo-ulnaris*, a muscle, according to his description, that takes origin from the internal condyle of the humerus and is inserted into the ulna. Thus far I have failed to discover the particular muscle to which he refers. From the synonymy given above it will be observed that Tiedemann and others designated it as the *Flexor brevis ulnæ.* Prof. Gadow's descriptions are in the main very brief, and the figures of his plates (for the most part copied from Alix, De Man, and Watson) are by no means satisfactory, so that it is possible, or more than likely, that one runs the chance of mistaking the muscle he refers to in some cases. I have omitted the synonymy in several instances, as will be noted below.

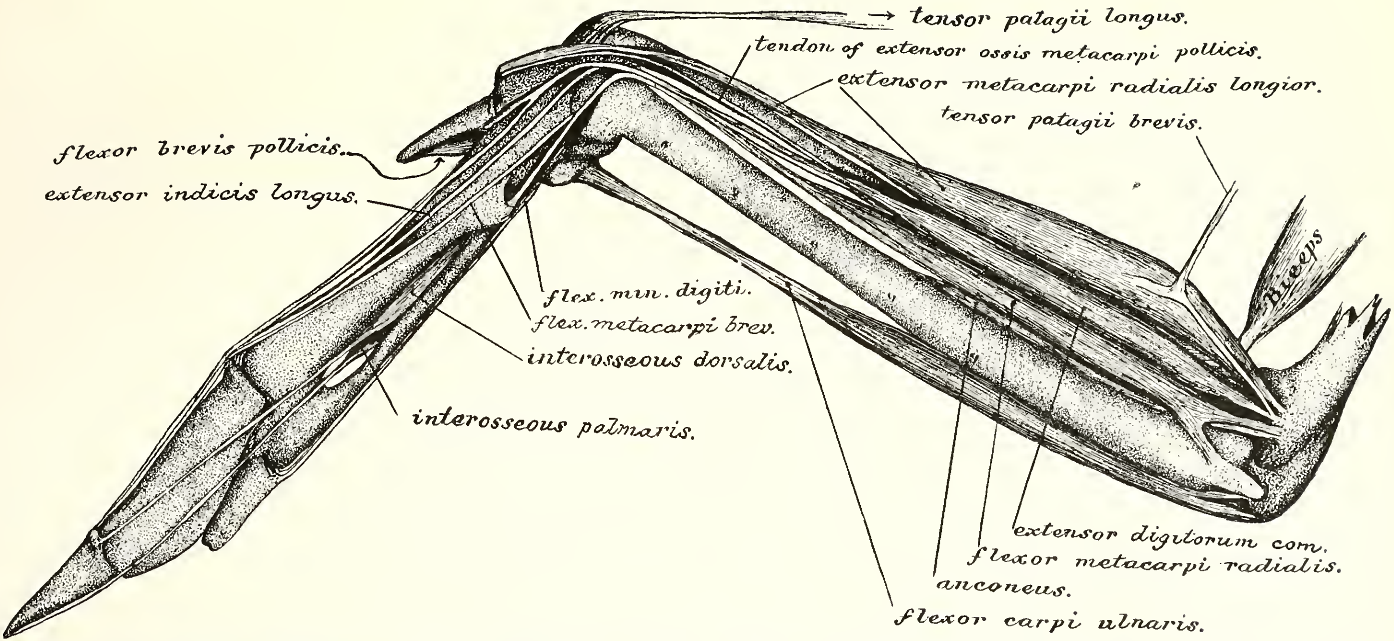

FIG. 38.—Outer aspect of left forearm and pinion of a Raven, showing the position, origin, and insertion of the superficial layer of muscles. The *tensor patagii longus* is drawn down a little towards the radius. Life-size, by the author, from his own dissections.

from above downwards, and its tendon of origin is seen to spread out over its proximal moiety on either side. In addition to its being a powerful muscle of pronation, it may act also as a flexor of the forearm upon the arm.

78. *The pronator longus*[1] is even a stronger muscle than the preceding, and possesses considerably more bulk. It comes off by a strong tendon from the middle of the internal condyle of the humerus, its fibres forming a massive ellipsoidal muscle, which, passing parallel to the *pronator brevis*, is inserted into the shaft of the radius, just beneath that muscle and rather posterior to it. The *pronator longus* is in intimate relation with the *brachialis anticus*, the *flexor digitorum profundus*, and other muscles lying beneath it. Its action is much the same as we described for the short pronator in the last paragraph.

79. *The extensor ossis metacarpi pollicis*[2] is, by all

[1] See footnotes under No. 77, *anteà*.

[2] I fail to find this muscle exactly described by Gadow as I have it here, and, as I say under its description above, it may be the *ext. metacarpi radialis brev.* of Tiedemann, Watson, and others.

However this may be, Gadow, I see, describes the following (*loc. cit.*, pp. 283, 284):—

"93. M. EXTENSOR POLLICIS LONGUS.

Le radial grêle.	Vicq d'Azyr, 1773, p. 574, No. 2.
Vorderer Handanleger.	Merrem, p. 157, No. 4.
Hülfsmuskel des Mittelhandstreckers.	Wiedemann (?).
Extensor metacarpi radialis brevis.	Tiedemann, § 269.
,, ,, ,, ,,	Heusinger, p. 187, No. 23.
,, ,, ,, ,,	Schöpss, p. 148, No. 32.
,, ,, ,, ,,	Watson, p. 95.
Kurzer Speichenstrecker.	Meckel, p. 334, No. 2.
Extensor pollicis longus.	Rüdinger, p. 131.
,, ,, ,,	Selenka, p. 133, No. 63.
,, ,, ,,	De Man, No. 27, Carlsson, p. 23.

odds, the smallest and most delicate muscle of the forearm in our present subject. It arises immediately in front of the "greater sigmoid cavity" of the ulna, in intimate relation with the fibres of the *anconeus*, and from the interosseous membrane close to the head of the radius, and I believe it may even extend to that bone for attachment. Its fibres form a very delicate, straight little muscle, completely hidden from sight by the others that surround it, and which does not exceed three centimetres in length, when it becomes converted into a tendon of absolutely hair-like dimensions. This passes directly to the wrist, parallel and in close connection with the *extensor metacarpi radialis longior*, to be inserted with it at the base of the first metacarpal, to its palmar side. In its action this little muscle plays the part of a feeble extender of the hand upon the forearm.

Mivart says that this "muscle may be double and very voluminous, as *e.g.* in the Chameleon. Even in very near allies of man (the Anthropoid Apes) it ends in two tendons, one going to the trapezium, the other to the metacarpal of the thumb" (*Elem. Anat.*, p. 336).

Kurzer Mittelhandstrecker. Prechtl, § 53.
Abductor du pouce. Gervais et Alix, p. 409 ; Alix, p. 409.

"Dieser Muskel entspringt, bedeckt vom Ext. indicis, von den einander zugekehrten Flächen des Radius und der Ulna, und zwar vom proximalen Theile derselben. Hierdurch erhält der Muskel eigentlich zwei mehr oder weniger getrennte Ursprungsköpfe. Dieselben vereinigen sich zu einer Sehne, die erst die Aussen—oder Vorderfläche des Radius begleitet und dann auf der dorsalen oder Extensorseite von einem eigenen Bande gehalten, über das Os carpi radiale läuft, um sich schliesslich an dem Vorsprunge des Metacarpale I. zu inseriren. . . . .

"Bei *Paradisea, Oriolus, Corvus* nach De Man ebenfalls zweiköpfig und zwar ist der radiale kopf der stärkere."

It is also found in the Horse, where the thumb is entirely absent. I fail to find an *extensor metacarpi radialis brevior*, so frequently described for birds by other authors, and it is just possible that this is the muscle alluded to by them. Of it, Owen says that it arises below the preceding [*extensor metacarpi radialis longior*] from the ulnar edge of the radius, and is inserted into the phalanx of the thumb immediately beyond the tendon of the preceding muscle [*extensor metacarpi radialis longior*]. The two tendons are quite distinct from one another in the birds of prey, the Ostrich and Parrots, but unite at the lower end of the forearm in the *Anatidæ*, *Phasianidæ*, and *Gruidæ*" (*Anat. of Verts.*, vol. ii. pp. 98–99).

80. *The anconeus*[1] is a very powerfully developed muscle in the forearm of the Raven. It arises by a short, though strong, subcylindrical tendon from the lower and back part of the external condyle of the humerus, and passes directly to the latero-radial side of the shaft of the ulna, along which it attaches itself to a point somewhat beyond its middle (Figs. 30 and 37).

On its inner side it is in intimate relation with the

[1] "83. M. ECTEPICONDYLO-ULNARIS.

Le fléchisseur profond de l'avant bras. Vicq d'Azyr, 1773, p. 573, No. 8; Cuvier.

Ohne Namen. Merrem, Fig. 3, v.

Kurzer Ellenbogenstrecker. Wiedemann, p. 91.

Unterer Kurzer oder vierter Ellenbogenstrecker. Meckel, p. 329, No. 6.

Flexor antibrachii profundus. Schöpss, p. 142, No. 29.

,, ,, ,, Gurlt, p. 23, No. 6.

,, ,, ,, Watson, p. 62.

Anconé. Alix, p. 407.

Anconæus quartus. De Man, p. 115. (Von Tiedemann, Prechtl, und Selenka nicht erwähnt.)" (Gadow, *loc. cit.*, p. 268.)

deep flexors of the forearm, and in that region its investing fascia shows a strong disposition to become tendinous, as may be observed from its striated and glistening white colour.

81. *The extensor indicis longus.*[1] — In *Corvus*, our

[1] Gadow makes the following remarks, and presents the following synonymy of this muscle, to wit :—

"94. M. EXTENSOR INDICIS LONGUS.

L'extenseur externe du doigt. Vicq d'Azyr, 1773, p. 574, No. 3.

Strecker des ersten und zweiten Gliedes des zweiten Fingers. Tiedemann, § 278.

Aeusserer oder hinterer Strecker des ersten und zweiten Gliedes des zweiten Fingers + Hülfsmuskel des äusseren Streckers. Heusinger, p. 193, No. 35 ; p. 194 und p. 196, No. 36.

Eigener Strecker des zweiten Fingers. Meckel, p. 344, No. 2.

Extensor indicis proprius longus. Schöpss, p. 159, No. 38.

Strecker des grossen Fingers. Prechtl, § 58.

Extensor digiti indicis proprius (*longus et brevis*). Selenka, p. 132, No. 62 ; Watson, p. 97 ; Carlsson, p. 24.

Extensor indicis longus. De Man, No. 27.

Extenseur de la deuxième phalange du doigt médian. Gervais et Alix, p. 28.

Extenseur de la deuxième phalange du deuxième doigt. Alix, p. 414.

"Der besondere Strecker des zweiten Fingers besteht meistens aus zwei nur mit ihren Endsehnen vereinigten Muskeln.

"I. Der grössere, stets vorhandene Theil liegt dorsal in dem von Ulna und Radius eingeschlossenen Raume und entspringt fleischig gewöhnlich von den mittleren zwei Dritteln der dorsal- und ulnarwärts schauenden Fläche des Radius, kann aber auch Fasern von der gegenüber liegenden Fläche des proximalen Endes der Ulna erhalten.

"Der Muskel geht am letzten Drittel des Vorderarmes in eine Sehne über, welche über eine Rinne auf der oberen Fläche des distulen Endes der Ulna läuft ; sie geht dann dorsalwärts über das Metac. II. hin zur Radialseite des zweiten Fingers, ist durch Bänder an das Gelenk des ersten Gliedes niedergedrückt und inserirt sich an der Radialseite des Caput. phal. I. und der Basis phal. II. dig. II. Ist wie bei *Lamellirostres*, *Grus*, *Numenius*,

present subject, it arises from the infero-ulnar aspect of rather more than half of the proximal moiety of the shaft of the radius, as a small and quite inconspicuous strip of muscle. This becomes converted into a long tendon, stronger than we might be led to expect from the size of the carneous portion of the muscle, which, passing over the groove at the distal end of the ulna, in company with the tendons of other muscles already described above, passes directly down on the anterior aspect of the hand to be inclosed in a fibrous sheath in front of the superior aspect of the first phalanx of the index digit; passing which, it is finally inserted into the anterior and upper rim of the distal phalanx of the same finger.

Struthio ein drittes Fingerglied vorhanden, so erstreckt sich die Sehne bis an die Basis desselben.

"Auf dem Metacarpal-Phalanx-Gelenke findet sich oft ein Sesambein. In der Carpalgegend wird die Sehne von der des Ext. dig. comm. bedeckt, späterhin aber wird sie zur oberflächlichsten und bedeckt ihrerseits die Zeigefingersehne des erwähnten Muskels. Der Ursprung des Muskels dehnt sich auf nahezu die ganze Länge des Radius aus bei *Corvus* und *Paradisea;* bei den *Raptores*, *Columbæ*, *Rasores*, *Grallæ* entspringt er ungefähr von der mittleren Hälfte, d. h. er lässt die Enden frei; er kommt nicht vom proximalen Drittel, geht dafür aber bis an das distale Ende bei *Psittacus*. Bei den *Spheniscidæ* ist er sehr schwach.

"II. Der zweite, kürzere Kopf entspringt vom Dorsalrande entweder des distalen Endes des Radius, vom Os carpi radiale oder von der Basis des Metac. II.; seine Sehne verbindet sich in der Nähe des distalen Endes des Metacarpus mit der Endsehne des grösseren Theiles.

"Dieser Hülfsmuskel findet sich nicht bei *Corvus*, *Paradisea*, *Fulica*, *Spheniscus*.

"Vergleichung. Entspringt nur unvollkommen dem Ext. indicis proprius des Menschen, da der Muskel bei den Vögeln fast ausschliesslich vom Radius anstatt von der Ulna entspringt." (Bronn's *Klassen*, *loc. cit.*, pp. 285, 286.)

81A. *The flexor digitorum sublimis.*—In dissecting the muscles of the forearm of a Raven one meets with a tendinous, somewhat muscular band, closely adherent to the integument, that stretches from the internal condyle of the humerus to the wrist, and from this latter point sends down a tendinous cord into the hand. I have not shown this structure in my figures, although it is generally recognized among the muscles by ornithotomical writers. Gadow describes it as follows:—

"90. M. FLEXOR DIGITORUM SUBLIMIS.

L'extenseur grêle de la partie qui tient lieu de doigt. Vicq d'Azyr, p. 572.

L'adducteur de la première phalange. Cuvier.

Fingerspanner (?). Merrem, p. 157.

Oberer oder langer Mittelhandbeuger. Wiedemann, p. 91.

Vorderer Strecker des ersten und zweiten Gliedes des zweiten Fingers. Heusinger, p. 191, No. 32.

Oberflächlicher langer Fingerbeuger. Meckel, p. 346, No. 3.

Flexor digitorum superficialis. Schöpss, 161, No. 39.

Flexor digitorum sublimis. Selenka, p. 135, No. 66.

" " " De Man, No. 31.

" " " Watson, p. 99.

" " " Carlsson, p. 27.

Le petit palmaire und *fléchisseur de la première phalange du second doigt.* Gervais et Alix, p. 29; Alix, p. 416.

(Tiedemann und Prechtl erwähnen diesen Muskel nicht.)

"Der oberflächliche Beuger der Finger wird von einer starken aponeurotischen Fascie bedeckt, welche nach Abtragung der Haut auf der Volarfläche des Unterarmes erscheint. Sie erstreckt sich vom Cond. int. humeri längs der Volarfläche der Ulna zur Handwurzel, wo sie sich mit einem Zipfel am proximalen Rande des Os carpi ulnare ansetzt, während der übrige Theil volarwärts an demselben Knochen sich befestigt. Der betreffende Muskel entspringt im allgemeinen von der dem Knochen zugekehrten Fläche dieser eigenthümlichen, gewöhnlich starken Sehne: die Insertionssehne des Muskels löst sich von letzterer etwas oberhalb der Handwurzel ab, und dann etwas volarwärts in einer eigenen Rinne

über das Os carpi ulnare, dabei von Bändern in ihrer Lage gehalten und darauf an der Mittelhand herab sich zur Radial-Vorderfläche des Phal. I. dig. II. zu begeben.

"Der Muskel und das Humero-carpal-Band sind grossen Verschiedenheiten unterworfen. Ist das Sehnenband sehr stark, wie bei *Anser*, *Carbo*, *Mormon*, *Uria*, *Tubinares*, *Heliornis*, *Otis*, *Oedicnemus*, *Tantalus*, *Parra*, *Raptores*, *Corvidæ*, so ist der Muskel schwach und dünn; bisweilen wie bei *Procellaria* und *Spheniscus* ganz rudimentär, die Endsehne bleibt aber gewöhnlich erhalten und geht zum Index. Ist dagegen das aponeurotische Band sehr schwach entwickelt, wei bei *Gallus* und *Numida*, so ist der Muskel auf dessen letztes Drittel beschränkt und vereinigt sich bisweilen mit der Sehne des Interosseus dorsalis.

"Der Ursprung der Muskels ist in verschiedener Ausdehnung auf die tiefe Fläche des Sehnenbandes beschränkt bei den Schwimm- Sumpf- und Tagraub-Vögeln, oder seine Fasern entspringen auch von den sich an die ganze Länge der Ulna zwischen M. flex. dig. profundus und M. flex. carpi ulnaris anheftenden Theile der Aponeurose (*Bubo*, *Podargus*, *Caprimulgus*). Bei *Parra chalcoptera* war das Sehnenband sehr stark, der Muskel schwach und ging nicht bis an den Phalangen, sondern verlor sich am Os carpi ulnare und etwas weiter abwärts auf und in den dortigen Aponeurosen.

"Die Insertion wechselt; jedoch scheinen die Verschiedenheiten von geringer Bedeutung zu sein. Am häufigsten (*Rasores*, *Raptores*) inserirt sich der Haupttheil der Endsehne an einer kleinen Anschwellung auf der Radialvorderfläche der Basis phal. I. dig. II., während der Rest sich schräg weiter distalwärts auf derselben Phalanx verliert. Zwischen diesen beiden Insertionstheilen tritt die Endsehne des M. flex. profundus hindurch, welche die von ihr perforirte Sehne des M. flex sublimis schon im Bereiche des Metacarpus begleitet hatte.

"Bei *Psittacus* und *Columba* setzt sich die Endsehne bis zur Basis phal. II. fort. Für *Otis* giebt Schöpss Insertion an der Basis phal. I. an. — Eine Insertion der Endsehne am Daumen scheint nicht vorzukommen, wohl aber erstrecken sich Sehnenzweige des Humero carpal-Bandes bis auf die Metacarpalia und den Daumen. Bei *Struthio* fehlt der Muskel sowohl als auch ein zwischen Humerus, Ulna und Carpus ausgespanntes Band.

. . . .

"Vergleichung. Entspringt mit Modificationen dem M. flexor digitorum sublimis s. perforatus der Säuger und theilweise der

oberflächlichen Beugemuskulatur der Reptilien und Amphibien." (Bronn's *Klassen des Thier-Reichs*, vi. Band, pp. 278, 279.)

It is a significant fact that neither Tiedemann nor Prechtl, two very close observing anatomists, described this muscle, nor had anything to say about it in their works.

82. *The flexor digitorum profundus*[1] arises fleshy by two strong heads from the proximal extremity of the ulna. Between these heads the *brachialis anticus* muscle passes to be inserted upon the same bone.

The radial head of the *flexor digitorum profundus* comes off immediately in front of the articular humeral facets and the tendon of the biceps, at about the middle point on the shaft, while the remaining head arises from the under side of the shaft as far over as the olecranon process. These heads, as the fibres pass wristwards, soon merge with each other, and the common muscle thus formed is attached for some little distance to the shaft of the ulna beneath it. After that, it rapidly converges to a point, and near the middle of the shaft becomes converted into its tendon. This passes to the ulnar side of the carpus through the various fascia-sheaths and fibrous loops there found, and once more emerges below the first metacarpal. From this point the strong tendon makes directly for the anterior aspect of the superior margin of the proximal phalanx of the index digit. Here it is again confined in a fibrous

[1] This muscle is designated also by this name in the works of Selenka (Bronn's *Klassen des Thier-Reichs*, p. 136, No. 67), De Man, Watson, and Carlsson ; likewise Gadow (*loc. cit.*, p. 279) so defines it for his muscle No. 91, presenting us with a synonymy of the same' referring to the writers dating from Vicq d'Azyr, as well as with a concise account bringing its history up to our present knowledge of its anatomy in Aves.

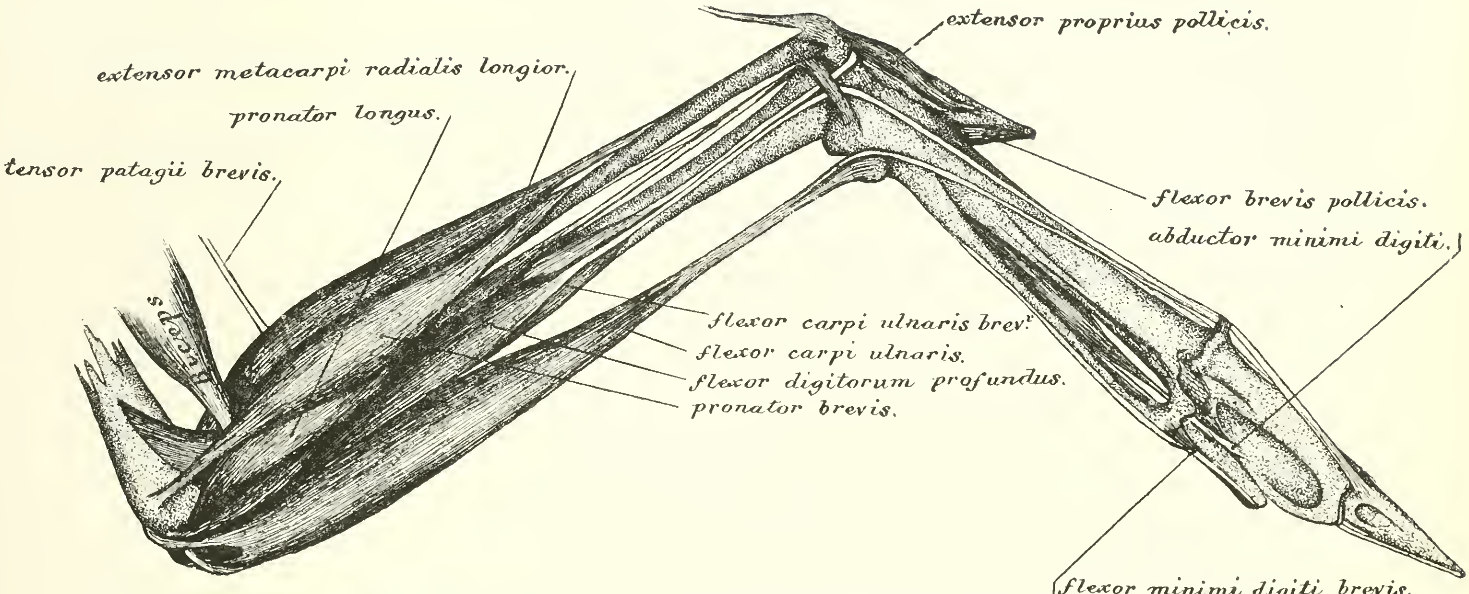

FIG. 39.—Inner aspect of left forearm and pinion of a Raven, showing the position, origin, and insertion of the superficial layer of muscles. Life-size, by the author, from his own dissections.

sheath, which it passes through to finally insert itself into the ulnar side of the base of the distal joint of the index finger.

Mivart says that "the *flexor profundus digitorum* in man possesses an exceptional distinctness and subdivision. As has been said, it may be intimately united with the *sublimis*, as it may also be (even in Monkeys) with the *flexor longus pollicis*. When distinct from the latter, it may yet send a tendon to the thumb, as in *Nycticebus*. It may end in but one, or at most two tendons, as in birds. In the complete separation of this muscle from the one next mentioned [*flexor longus pollicis*] man differs from all the Apes" (*Elem. Anat.*, p. 332).

83. *The flexor carpi ulnaris*[1] is an exceedingly interesting muscle, and is the one that makes up the fleshy mass on the under side of the forearm for its posterior moiety. On the ulnar side of the olecranon process of the larger bone of the antibrachium we find a

[1] "85. M. FLEXOR CARPI ULNARIS S. ENTEPICONDYLO-CARPALIS.

Le cubital interne. Vicq d'Azyr, 1773, p. 573, No. 6.
" " " Cuvier.
Ausdehner des Arms + Regierer der Armfedern. Merrem, p. 155, No. 6 und 7.
Langer Ellenbogenbeuger. Wiedemann, p. 22.
Flexor carpi ulnaris. Tiedemann, § 272.
" " " Heusinger, p. 189, No. 26.
" " " Selenka, p. 133, No. 64.
" " " Rüdinger, p. 158.
" " " Watson, p. 93 ; Carlsson, p. 29.
Innerer Ellenbogenmuskel. Meckel, p. 336, No. 6.
Langer Beuger der Handwurzel + *M. rector remigum secundi ordinis.* Schöpss, p. 154, No. 35, und p. 88, No. 4.
Antagonist des langer Mittelhandstreckers. Prechtl, p. 54.
Cubital antérieur. Gervais et Alix, p. 29.
Métacarpien palmaire interne. Alix, p. 412, pl. II., fig. 2, No. 15, 16, 17." (From Gadow, Bronn's *Thier-Reichs*, vi. Band, p. 270.)

fibro-cartilaginous loop developed; one end of this is attached to the middle point of the posterior aspect of the internal condyle of the humerus, while its other end is fast to the ulnar side of the base of the olecranon process. We will call this the *humero-ulnar pulley*. Now, the origin of the *flexor carpi ulnaris*, the muscle under consideration, is concerned with this very structure, for we find that the muscle arises by two strong tendons; the one on the side towards the olecranon process, passing through the *humero-ulnar pulley*, makes fast to the back of the internal condyle of the humerus; while the outer tendon attaches itself to the same protuberance, but at its outer aspect, and without the "pulley."

These tendons are somewhat flattened, and each about a centimetre long, when they merge into a strong, fusiform muscle, occupying rather more than the posterior half of the under side of the forearm. From the anterior apex of this muscle a powerful and subcylindrical tendon stretches directly to the back of the *ulnare* ossicle of the carpus, where it makes an extensive attachment. Just before reaching this ossicle the tendon of the *flexor carpi ulnaris* differentiates off a small tendinous slip, which, passing through a fibrous loop at the ulnar side of the carpus, goes obliquely downwards to the tendon of the *flexor digitorum profundus*, and merges with it at a point about opposite the distal apex of the pollex digit; or, more strictly speaking, is contained in the same sheath with this tendon of the *flexor digitorum profundus* tendon as far as the anterior rim of the proximal phalanx of the index digit, where this offshoot becomes inserted.

In its action this muscle is a powerful flexor of the hand upon the forearm, and its tendinous offshoot at the carpus is not an inefficient aid to the action of the

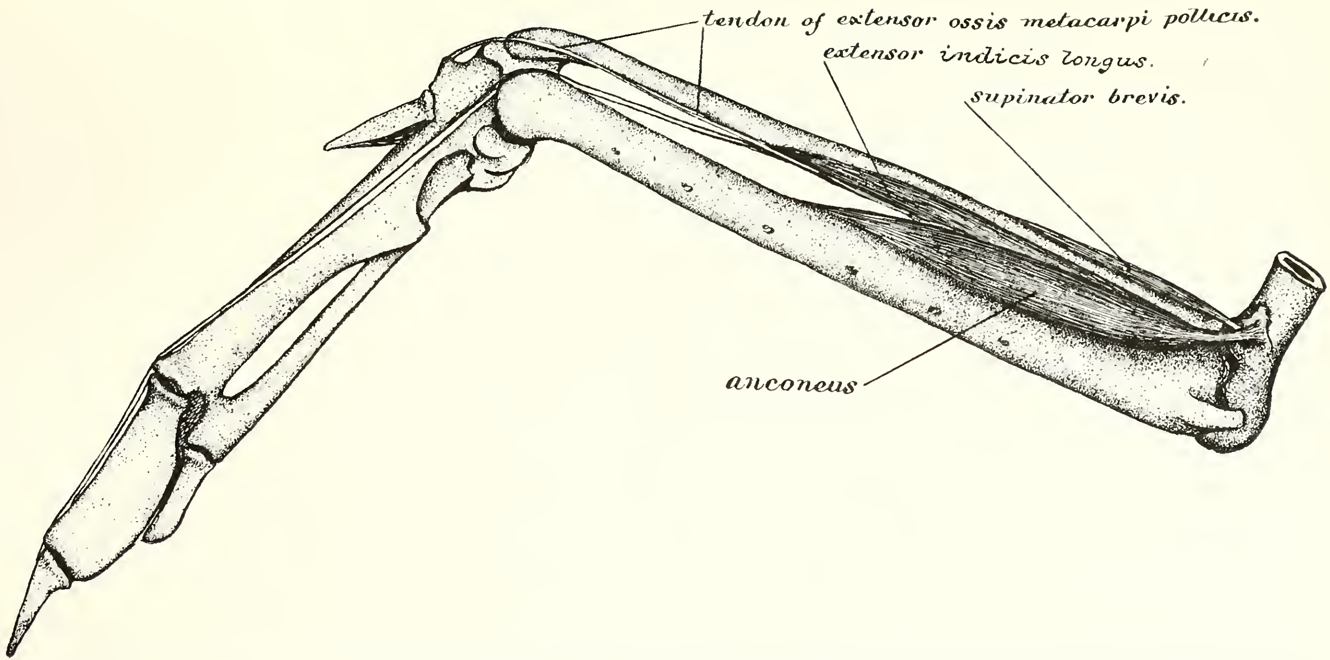

Fig. 40.—Outer aspect of forearm and hand of a Raven, showing relative position, origin, and insertion of the deep layer of muscles. Life-size, by the author, from his own dissections.

flexor digitorum profundus. Owen calls this muscle the *flexor metacarpi ulnaris*, and says of it in the *Apteryx* that it "arises beneath the forearm from the internal pulley of the ulna; continues fleshy to the pinion; and is inserted, first into the ulnar carpal bone, then into the ulnar phalanx. The latter insertion is wanting both in the Ostrich and Penguin" (*Anat. Verts.*, vol. ii. p. 99).

When we come to examine it carefully in the Raven, especially the distinctness of its external head, and a median fascia that runs longitudinally through its belly, and finally its distal tendinous offshoot, it is not difficult for us to imagine that the muscle originally was composed of two parts, or perhaps two distinct muscles (Figs. 31 and 36).

84. *The flexor carpi ulnaris brevior*[1] is a muscle that I do not find described in any work at present available to me, and which I here provisionally bestow this name upon in view of the fact that the *flexor carpi ulnaris* is often split up into several portions in some other vertebrates, and this is more than likely an instance of it. And then, again, I was influenced in my decision from the additional fact that in its action it assumes *in part* the function of the *flexor carpi ulnaris* in those animals where it does occur normally. The *flexor carpi ulnaris brevior* in the Raven, however, not only to a limited extent flexes the hand upon the forearm, but by its peculiar carpal insertion rotates the hand *towards* the side of the body—a very important action during flight.

This muscle arises from quite a broad area covering the middle third of the upper side of the shaft of the

[1] From Gadow's account (*loc. cit.*, p. 272) I would say that this muscle was represented by his No. 86. M. ULNI-METACARPALIS VENTRALIS—the *adductor metacarpi* of Schöpss and of Watson.

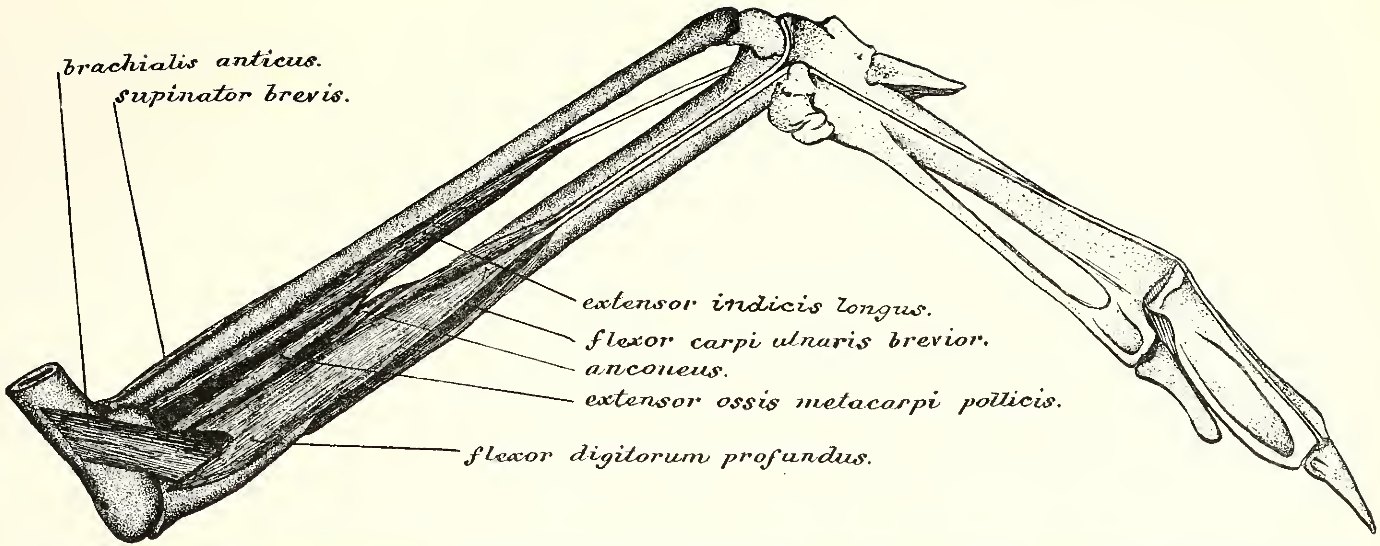

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Fig. 41.—Inner aspect of forearm and hand of a Raven, with the superficial layer of muscles dissected away, showing the origins and insertions of the deep layer. Life-size, by the author, from his own dissections.

ulna (Fig. 37), being found immediately beneath the *flexor digitorum profundus*, or rather the anterior portion of its muscular division, and the posterior third of the tendon that comes off from it. The carneous portion of the *flexor carpi ulnaris brevior* is entirely attached to the ulna, while its exposed surface is covered by a glistening, tendinous fascia. This merges, anteriorly, into its true tendon, which passes from the apex of the muscle directly to the carpus, well above the ulna's shaft. At the carpus it winds around in front of the *radiale* bone, from the ulnar side, to become inserted upon the *outer* edge, near the top, of the anchylosed *os magnum* of the carpo-metacarpus. This anterior portion of the tendon is firmly held in its position by a strong fibrous sheath, in which it plays.

This muscle can only be satisfactorily examined by removing the other muscles of the forearm; and, indeed, I have taken up all the muscles of this division of the pectoral limb in the order in which they most conveniently occur for examination. So that, for the student to follow my work, he will find his task much lightened by investigating them in the same order, *i.e.* from 73 to 84 inclusive, as given in the list.

To complete our musculature of the upper extremity we have yet to consider those muscles, several in number, which may be regarded as the intrinsic ones of the hand. In the extensive chapter on the muscles of birds, in his *Anatomy of Vertebrates* (vol. ii.), Professor Owen simply alludes to these muscles, and neither gives their names nor otherwise describes them; while Professor Mivart has nothing to say about them so far as they occur in Aves, in his *Anatomy*. Consequently, we shall be obliged to name them as their localities, origins, and insertions seem to indicate.

In the Raven they are found to be as follows:—

85. The extensor proprius pollicis.
86. The flexor brevis pollicis.
87. The flexor minimi digiti.
88. The flexor minimi digiti brevis.
89. The abductor minimi digiti.
90. The flexor metacarpi brevis.
91. The interosseous dorsalis.
92. The interosseous palmaris.

85. *The extensor proprius pollicis*[1] is a neatly arranged little muscle admirably adapted to the extension of the pollex digit. Spindle-shaped in form, it arises from the ulnar side of the tendon of the *extensor metacarpi radialis longior*, and is inserted into the antero-ulnar side of the pollex phalanx, being tendinous both at its origin and its insertion.

A muscle of this name is described by human ana-

[1] Selenka and De Man considered this to be an abductor of the thumb, and Gadow has given us the following synonymy for the muscle:—

"98. M. ABDUCTOR POLLICIS.

Innerer Daumenstrecker (*Extensor pollicis internus*). Wiedemann, p. 93; Schöpss, No. 42.
Langer Daumenstrecker. Tiedemann, § 274.
" " Prechtl, § 63.
Langer oder innerer Daumenstrecker. Heusinger, p. 190, No. 28 (*Extensor pollicis*).
Ohne Namen. Meckel, p. 349, No. 3.
Abductor pollicis brevis. Selenka, p. 138, No. 73.
Abductor pollicis. De Man, No. 37.
L'abducteur direct de l'appendix. Court abducteur palmaire. Alix, p. 418.

"Entspringt fleischig von der Ventralfläche der Sehne des *M. extensor metacarpi radialis* etwas proximal von dessen Insertion an dem hervorstehenden Knorren des Metacarpale I. Der ziemlich rundliche Muskel windet sich an der Volarfläche jenes Knorrens vorbei und inserirt sich mit kurzer Sehne an dem radialen oder vorderen innerer Vorsprunge des Pollex oder etwas distal davon" (Bronn's *Klassen*, vi. Band, p. 289).

tomists for the foot, but it is incorrectly termed, as it should be called the *extensor proprius hallucis.*

86. *The flexor brevis pollicis* arises from the shaft of the mid-metacarpal bone of the carpo-metacarpus, just below the anchylosed first or pollex metacarpal. Its fibres converge as they pass down behind the thumb joint, to become converted into a delicate tendon which is inserted into the distal apex of that phalanx.

Thus we see that the pollex of the Raven is supplied with two extensors and one flexor. When the wing is fully extended and the tendon of the *extensor metacarpi radialis longior* is on the stretch, and at the same time the tendinous slip from the *extensor digitorum communis* is pulling on this digit, it is held in full extension, by virtue of the several methods of attachment of the muscles, and the wing feathers attached to it are in this way so spread as to present the greatest amount of superficial area to the atmosphere. When the wing is closed, the more delicate flexor of the thumb draws that joint down again towards the metacarpus, and is sufficiently powerful to retain it in that position.[1]

87. *The flexor minimi digiti,*[2] instead of going to the little finger as in a five-fingered hand (as in *Homo*), it is inserted into the smallest finger-joint of the bird's hand, which, as we know, corresponds with the medius.

[1] We find, upon referring to Selenka's excellent work in Bronn's *Thier-Reichs* (vi. Band, p. 138, No. 71), that he designates this muscle as the *flexor pollicis brevis,* while Gadow describes it briefly as the M. ADDUCTOR POLLICIS (No. 101) (*loc. cit.*, pp. 291, 292).

[2] Here we have the muscle that Watson defined as the *flexor minimi digiti* (p. 99), and which has been amply recognized by other writers. Gadow made it his (No. 102) M. FLEXOR DIGITI III., and remarked that "Bei *Corvidæ* ist der Muskel nur schwach entwickelt und, wenn überhaupt vorhanden, mehr auf den dorsalulnaren Rand beschränkt" (*loc. cit.*, p. 293).

It arises fleshy from the posterior aspect of the medius metacarpal close up to the os magnum, with a few fibres extending to the ulna (Fig. 44), and these two portions converging, they soon send down the back of the carpo-metacarpus, in a groove intended for it, a delicate tendon which is inserted with the posterior margin of the base of the medius phalanx.

88. *The flexor minimi digiti brevis*[1] is in a very

[1] Neither this muscle nor the next, my No. 89, is apparently described by Professor Gadow, and, indeed, I fail to find them recognized by other writers on the subject, unless it be Selenka. On the other hand, I find Gadow giving two muscles (herewith reproduced below) that were not revealed to me during my dissections upon the Raven :—

"96. M. ABDUCTOR INDICIS.

L'adducteur de la première phalange. Cuvier.
Strecker des ersten Fingergliedes. Wiedemann, p. 94.
Strecker des ersten Gliedes des zweiten Fingers. Tiedemann; Heusinger, p. 193, No. 34.
Anzieher des zweiten Fingers. Meckel, p. 350, No. 8.
Anzieher des Zeigefingers (*Adductor phalangis primæ indicis*) Schöpss, p. 170, No. 45.
Niederzieher des grossen Fingers. Prechtl, § 61.
Court extenseur du médius. Milne-Edwards, pl. 10, fig. 1.
Vierter Interosseus. Selenka, p. 137, No. 70.
Interosseous IV. De Man, No. 36.
L'abducteur du deuxième doigt. Gervais et Alix, p. 29.
L'abducteur palmaire du deuxième doigt. Alix, p. 419.
Abductor digiti secundi. Watson, p. 100.
Abductor indicis. Carlsson, p. 28.

"Dieser Muskel kommt fleischig von der Radialfläche des Metacarpale II. und zwar am gewöhnlichsten von dessen proximalem Drittel dabei auf die Ventralseite übergreifend. Bei besonderer Entwicklung erstreckt sich der Ursprung auf die ersten drei Viertel (Tauben, Raubvögel) oder wohl auch auf nahezu die ganze Länge jenes Knochens (*Anser, Ibis, Psittacus*), jedoch kann er, obgleich

rudimentary condition, though we have no trouble in making it out.

It arises from the lower and posterior end of the medius metacarpal, and from the adjacent tendon of the preceding muscle; at least its meagre carneous portion does, but its rather strong tendon, which has the same osseous origin, is continued directly to its point of insertion, the apex of the medius digit. So that in function this muscle in the Raven is rapidly coming to play the part of a *posterior ligament* to this joint, and securely splices this now almost useless little finger to the next digit by aid of the surrounding tissues, and thus keeps it out of harm's way.

auf die proximale Hälfte beschränkt, doch recht stark sein z. B. bei *Bucorvus* und *Podargus*. . . . .

"Insertion. Die kurze starke Sehne verläuft an der Innen-Vorder Kante des Metacarpale II. und inserirt sich am Innen-Vorderhöcker der Basis phal. I. dig. II."

In referring to Selenka's work in Bronn's *Thier-Reichs* (vi. Band, p. 137), as noted in the above synonymy, I find that that anatomist defines this muscle, his No. 70, as the *abductor digiti minimi*, and I have every reason to believe that this muscle corresponds with my No. 89, the *abductor minimi digiti*.

"97. M. FLEXOR POLLICIS.

Anzieher des Daumens (*Adductor pollicis*). Wiedemann, p. 94 Schöpss, No. 43; Heusinger, p. 191, No. 31; Selenka, p. 138, No. 74.

Anzieher oder Einwärtszieher (*Adductor pollicis*). Tiedemann, § 282.

Ohne Namen. Meckel, p. 349, No. 4.

Einwärtszieher des Daumens (pt.). Prechtl, § 65.

Les courts fléchisseurs du pouce. Alix, p. 418.

Flexor pollicis brevis. Carlsson, p. 28." (Bronn's *Klassen*, &c., p. 288.)

Gadow also describes another muscle (No. 100 of his list), the *m. extensor pollicis brevis* (*loc. cit.*, p. 291), of which he says that "So wird er bei den *Corvidæ* von Schöps als nicht gefunden, von De Man als zweifelhalf angegeben."

89. *The abductor minimi digiti* is a small muscle, almost reduced to a ligamentous band, which arises by a rather strong tendon and a few indistinct fibres from the proximal extremity of the anterior aspect of this medius digit, to pass downwards and become inserted upon the posterior border of the proximal phalanx of the index finger, at a point rather above the tip of the medius digit. The action of this now highly rudimentary muscle is very feeble, but, such as it is, it is opposed to the more powerful flexors applied to the back of this joint.

90. *The flexor metacarpi brevis*[1] arises partly fleshy and partly tendinous from the outer side of the distal extremity of the ulna; the carneous portion ceases at a point about opposite the base of the thumb-joint. From this point a delicate tendon passes obliquely down the carpo-metacarpus to become inserted at the base of the proximal phalanx of the index digit, on its ulnar side, in front.

[1] This muscle has been defined as the *m. ulni-metacarpalis dorsalis* by Gadow, who records the following synonymy for it (*loc. cit.*, pp. 273, 274):—

"87. M. ULNI-METACARPALIS DORSALIS.

Le court fléchisseur de l'os métacarpe. Vicq d'Azyr, p. 577, No. 3.
Flexor metacarpi brevis. Tiedemann, § 273.
,, ,, ,, Watson, p. 96.
,, ,, ,, Heusinger, p. 190, No. 27.
Unterer Theil des äusseren Ellenbogenmuskels. Meckel, p. 335, No. 4.
Kurzer Beuger der Mittelhand. Schöpss, p. 156, No. 36.
,, ,, ,, ,, Prechtl, § 56.
Flexor carpi radialis. Selenka, p. 134, No. 65.
Court fléchisseur de la main. Milne-Edwards.
Le court adducteur de la main. Gervais et Alix, p. 28.
Court fléchisseur du métacarpe. Alix, pl. II. fig. 2, No. 21.
Second ou court cubital postérieur, ou court adducteur de la main. Alix, p. 140."

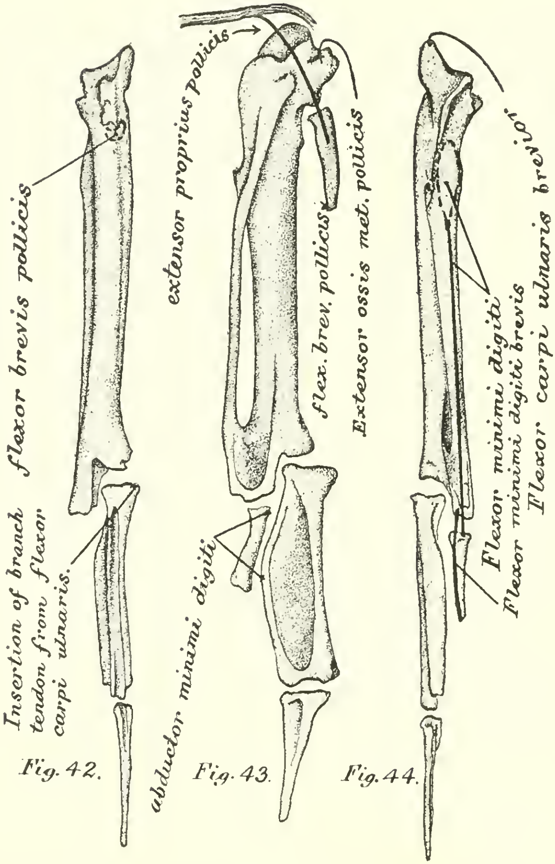

Fig. 42.—Anterior aspect of the bones of the left hand of a Raven, with the pollex digit removed; designed to show the origin and insertion of some of the muscles or their tendons.

Fig. 43.—Ulnar aspect of the same bones; the axis of the *extensor proprius pollicis* muscle is shown, and its origin indicated upon a piece of the *extensor metacarpi radialis longior*, given above.

Fig. 44.—Posterior aspect of the same bones. The several segments in all the figures are slightly dislodged in order to show them to better advantage. Specimens all life-size, and drawn by the author.

The action of this muscle is to flex the hand upon the forearm, and at the same time rotate it slightly to the inner side.

91. *The interosseous dorsalis* is the outermost and higher of the two delicate muscles that fill the long vacuity existing between the index and medius metacarpal. It is attached to the margins of the shafts of both these bones, then sends obliquely downwards a slender tendon, which lies flat against the radial side of the skeleton of the hand, to be finally inserted at a point on the anterior aspect of the base of the distal phalanx of the index digit. The contraction of this muscle extends the lowermost finger-joint of the hand in the Raven.

92. *The interosseous palmaris* [1] lies in the same vacuity,

[1] Gadow offers the following synonymy for the two *interosseous* muscles I describe above, to wit:—

" 95. M. INTEROSSEUS DORSALIS.

L'interosseux antérieur. Vicq d'Azyr, p. 577.
Aeusserer Mittelhandmuskel (*Interosseus externus.*) Tiedemann, § 283: Heusinger, p. 197, No. 39.
Innerer Strecker und Abzieher des zweiten Fingers. Meckel, p. 350, No. 6.
Abzieher des Zeigefingers (*Abductor phalangis secundæ indicis*). Schöpss, p. 172, No. 46.
Oberer Mittelhandmuskel (Vorleger der Lenkfeder.) Prechtl, § 66.
Interosseux antérieur ou abducteur du médius. Milne-Edwards, pl. 9, fig. 3.
Interosseus. Selenka, p. 137, No. 69.
Interosseus II. ulnaris. De Man, No. 34.
Interosseux dorsal. Gervais et Alix, p. 30.
L'adducteur dorsal du deuxième doigt. Alix, p. 419.
Interosseus dorsalis. Watson, p. 100; Carlsson, p. 25.

" 99. M. INTEROSSEUS PALMARIS.

L'interosseux postérieur. Vicq d'Azyr, p. 577.
Innerer Mittelmuskel (*Interosseus internus*). Tiedemann, § 284; Heusinger, p. 197, No. 40.
Aeusserer Strecker und Abzieher des zweiten Fingers. Meckel, p. 350, No. 7.
Beuger des Zeigefingers. Schöpss, p, 173, No. 47.

beneath the preceding muscle, while its fleshy portion extends somewhat lower down in this intermetacarpal fenestra to which it is attached than its companion. Its tendon passes down in a manner similar to that described for the *interosseous dorsalis*, but is carried completely to the distal apex of the lowermost joint of the index finger, being next to its posterior margin. When this delicate little muscle contracts it flexes to a marked degree the joint to which it is attached, and if its contraction is carried to the full extent of which it is capable, it will also flex both the digital joints of the index finger, provided the opposition of the more powerful extensors is not applied at the time.

Unterer Mittelhandmuskel (Zurückzieher der Lenkfeder.) Prechtl, § 67.

Interosseux postérieur ou court fléchisseur du médius. Milne-Edwards, pl. 9, fig. 3.

Interosseus. Selenka, p. 137, No. 69.

Interosseus I. radialis. De Man, No. 33.

Interosseux palmaire. Gervais et Alix.

L'adducteur du deuxième doigt. Alix, p. 419.

Interosseus palmaris. Watson, p. 101." (Bronn's *Klassen des Thier-Reichs*, vi. Band, p. 290.)

VIII. THE MUSCLES OF THE LOWER EXTREMITY.

To expose these, extend the median dorsal excision through the integuments, to the very tip of the coccyx; join this by an extension of the median integumental ventral incision. Next, join these two lines anteriorly by a lateral division of the integuments, which above passes immediately behind the point of the scapula. Reflect the skin thus set free, and carefully remove it as far as the ankle-joint. Here we meet with the horny podotheca covering the tarso-metatarsus and toes. This is best removed by lateral incisions and peeling backwards and forwards both ways, being particularly careful not to injure the tendons.

The following superficial muscles of the thigh are now to be examined:—

93. The sartorius.
94. The gluteus primus.
95. The gluteus medius.
96. The gluteus minimus.
97. The extensor femoris (the cruræus, the vastus externus.)
98. The vastus internus.
99. The biceps flexor cruris.
100. The semitendinosus.
101. The accessory semitendinosus.
102. The semimembranosus.
103. The femoro-caudal.
104. The obturator externus.
105. The obturator internus.
106. The gemellus.
107. The abductor longus.
108. The adductor magnus.
109. The gastrocnemius.

110. The soleus.
111. The peroneus longus.
112. The tibialis anticus.
113. The extensor longus digitorum.
114. The extensor hallucis brevis.
115. The tibialis posticus.
116. The flexor perforatus indicis secundus pedis.
117. The flexor longus hallucis.
118. The flexor perforatus annularis primus pedis.
119. The flexor perforatus medius primus pedis.
120. The flexor perforatus medius secundus pedis.
121. The flexor perforatus indici primus pedis.
122. The flexor perforans digitorum profundus.

93. *The sartorius*[1] constitutes the most anterior of the group of superficial muscles upon the outer aspect of the thigh in the Raven, as it does in the vast majority of birds.

It arises by a fleshy origin from the outer two-thirds of the superior surface of the raised emargination of the anterior border of the ilium, and by a few fibres and an extension of its fascia, from the crest of the neural spine of the fourth dorsal vertebra (Fig. 24). The muscle

[1] Gadow has given us a very excellent account of this muscle for birds, together with the subjoined synonymy, to wit:—

"33. M. ILIO-TIBIALIS INTERNUS S. SARTORIUS.

M. quartus tibiam movens. Aldrovandi.
M. primus femoris. Steno.
Le couturier. Vicq d'Azyr, p. 272, No. 1; Cuvier, p. 524; Gervais et Alix, p. 30; Alix, p. 438.
Ausstreckender Schienbeinmuskel. Merrem, p. 159, No. 1.
Sartorius. Wiedemann, p. 94.
" Tiedemann, § 294; Gurlt, p. 28.
" Owen, *Apteryx*, p. 292.
" Quennerstedt, p. 23.
" Neander, p. 15; Selenka, p. 142, No. 82.
" De Man, p. 125, 11.
" Gadow, No. 13.
" Watson, p. 109.
Rectus femoris. Reid, p. 143." (Bronn's *Klassen*, vi. Band, p. 149.)

becomes much thicker and bulkier as it descends downwards and backwards towards the knee, its anterior margin forming the free edge that bounds the group of thigh-muscles in this region.

It is inserted, rather obliquely, by a semitendinous fascia into the inner edge of the ligamentum patellæ, and by a somewhat stronger attachment to the inner and contiguous border of the summit of the tibia for its anterior half.

The sartorius is one of the extensors of the leg, it also flexes and to some extent adducts the thigh.

"We find the *sartorius* muscle (Fig. 62 *bis*) powerfully developed in *Geococcyx*, as are the majority of the muscles of the thigh in that bird. It arises, semitendinous, from the crest of the neural spine of the last vertebra of the dorsal region of the spine, from the summit of the anterior portion of the crista of the sacrum, and from the adjacent surface of the superior aspect of the ilium on the corresponding side. The fibres, forming an oblong and rather thick muscle, pass downwards and backwards to the region in front of the knee. Here it becomes inserted by a special slip of fascia that is thrown off and merges with the general fascia surrounding the knee-joint; and, secondly, by a more carneous insertion into the inner half of the superior rim of the cnemial crest of the tibia and the continuous inner margin of the summit of that bone.

"The *sartorius* in this bird bounds anteriorly the superficial group of muscles of the thigh; consequently its anterior border is free. Its posterior border above unites quite intimately with the overlapping *gluteus primus* muscle; while this border below is sharp and free, although here, too, the *gluteus* also overlaps it,

and a delicate connective tissue binds them together." (See 120 of *Bibliography.*)

94. *The gluteus primus* is the most superficial of all the muscles of the thigh, and but requires the removal of the skin to bring it into full view. It overlaps the preceding muscle in front and a number of the deeper ones behind.

It arises by a thin fascia for nearly the entire length of the supero-internal margin of the pre-acetabular portion of the ilium, also from this bone above the antitrochanter, and by a stronger origin from the entire length of the postacetabular ridge. The anterior portion of the muscle is thin and fascia-like, while behind it is better developed. In front it forms a delicate covering to the hinder moiety of the *sartorius*, and the body of the *gluteus medius*; behind, the *biceps* is the principal muscle covered by it. From this long line of origin, the fibres of this triangular muscle converge as they pass downwards toward the patella, and just before reaching that sesamoid they merge with the fibres of the *extensor femoris.*

The combined muscles then form an extensive, thin aponeurosis, which spreads over the anterior aspect of the knee, and is inserted into the crest of the cnemial border of the tibia, the well-developed patella being found in this aponeurotic ligament.

In his earlier papers, Professor Garrod called this muscle "*tensor fasciæ*"; and Sir Richard Owen, speaking of it in the Apteryx, says that "the most superficial of the muscles on the outer side of the leg is that very broad one which combines the functions of the *tensor vaginæ* and *rectus femoris,* but which, in the opinion of Cuvier and Meckel, is the homologue of the *tensor vaginæ* and *gluteus maximus* (*seu externus*)" (*Anat. of Verts.,* vol. ii. p. 99).

In the Raven its anterior fasciculus can be separated almost as a distinct muscle, and this portion has its distal tendinous slip inserted more particularly over the anterior surface of the patella.[1]

[1] By the older anatomists this *gluteus primus* muscle was considered in its entirety in their descriptions, and it has, as will be seen, so been considered here. More recent writers, however, and very properly so perhaps, have divided this complex muscular mass into three portions, of which the anterior portion is generally taken to represent the *rectus femoris ;* the middle portion, the *tensor fasciæ latæ ;* and the hinder division a "*m. glutæus posterior.*"

Gadow has admirably handled the subject, and the entire muscle is claimed by him to be an *ilio-tibialis*, and capable of division into three parts. From this authority I here below obtain my synonymy, and likewise republish largely from his account (see Bronn's *Thier-Reichs*, vi. Band, pp. 151–153) :—

" 34. M. ILIO-TIBIALIS.

" A. Der ganze Muskel-Complex.

M. primus tibiam movens. Aldrovandi.
M. secundus femoris. Steno.
Latissimus femoris. Wiedemann, p. 94.
Latissimus femoris = Tensor fasciæ latæ. Tiedemann, § 295.
Tensor fasciæ latæ. d'Alton, p. 33.
Tensor fasciæ et caput longum m. bicipitis femoris. Gurlt, p. 28.
Rectus femoris et tensor fasciæ. Quennerstedt, p. 24.
,, ,, ,, ,, Neander, p. 16.

" B. Die einzelnen Theile.

" I. *M. ilio-tibialis anterior.*

M. rectus femoris. Owen, *Apteryx*, p. 292.
,, ,, Selenka, p. 142, No. 83.
,, ,, De Man, p. 124, No. 10.
,, ,, Watson, p. 110.
M. ilio-tibialis externus. Gadow, No. 14.

" II. *M. ilio-tibialis medius.*

M. du fascia lata. Vicq d'Azyr, p. 272, No. 2 ; Cuvier, p. 523.
M. tensor fasciæ latæ. Meckel, *System,* p. 360, No. 1 ; Gadow, No. 22.

95. *The gluteus medius* is a very different muscle from the one just described, and in regard to it anatomists

Auswärtswender und äusserer Beuger. Meckel, *Archiv*, p. 259, No. 1.
Schenkelbindenspanner. Meckel, *Archiv*, p. 259, No. 1.
Tensor vaginæ. Owen, *Apteryx*, p. 292.
 ,, ,, Selenka, p. 142, No. 84.
 ,, ,, De Man, p. 124, No. 9.
Tenseur du fascia lata. Gervais et Alix, p. 110.
Tensor fasciæ femoris. Watson, p. 111.

" III. *M. ilio tibialis posterior.*

Grand fessier. Vicq d'Azyr, p. 272, No. 3 ; Cuvier, p. 523.
Grosser Gesässmuskel (hinterer Theil). Meckel, *System*, p. 361, No. 1 ; *Archiv*, p. 259, No. 1.
Grand fessier. Gervais et Alix, p. 30 ; Alix, p. 430.
M. glutæus posterior. Gadow, No. 22.

" Die äussere, oberflächliche Lage der Muskulatur des Oberschenkels wird von einer breiten, oft nur dünnen Muskelmasse gebildet, die drei verschiedene Muskeln repräsentirt. Da sie hinsichtlich ihrer Ausbildung in Zahl und Ausdehnung die grösste Mannigfaltigkeit zeigen, so wollen wir zuerst ihr typisches Verhalten feststellen. Dieses finden wir bei den *Hühnern* und *Kranichen.* Die Muskellage entspringt aponeurotisch vom ganzen dorso-lateralen Rande des präacetabularen und acetabularen *Ilium*, ferner mehr fleischig vom correspondirenden Kamme des postacetabularen Ilium, dabei etwas auf das distale ende des *Ischium* übergreifend, welcher Theil dann vom *M. caud. il. flexorius* bedeckt wird. Die Muskelfasern dieser breiten Schicht convergiren nach dem Kine zu, erreichen dasselbe aber nicht, sondern heften sich mit einer starken Aponeurose auf dem Endtheile des tiefer liegenden *M. fem. tib.* fest, verstärken mithin dessen zur *Patella* tretende Sehne.

. . . .

" Die hauptsächlichsten Verschiedenheiten sind folgende :

" Erstens in Bezug auf die Insertion. Die ganze Muskelmasse ist distal verkürzt und inserirt bereits auf der Mitte des *M. femoro-tibialis*, ohne also das Kine zu erreichen (*Ciconia*, *Ibis*, Tauben, Raubvögel, Papageien) ; oder sie reicht ziemlich bis zum Kine (die meisten Sumpf-, Hühner-, Schwimm-, und Singvögel). Der *M. ilio-*

are, and generally have been, well agreed as to its homology. It comes off from the entire supero-internal

tibialis anterior ist dabei gewöhnlich der längere. Bei *Podiceps*, nicht jedoch bei *Colymbus*, ist fast nur der mittlere, dem *M. ilio-tib. medius* entsprechende Theil entwickelt; dieser ist aber sehr breit und inserirt sich an der *Patella*, auch durch Verwachsung an der Hinteraussenfläche des *M. gastrocnemius*, dabei bis zur Mitte des Unterschenkels herabreichend. Bei den *Spheniscilen* inserirt sich der mittlere und der sehr reducirte hintere Theil zusammen mit dem *M. femoro-tibialis* an der Aussenseite der Patella und am oberen Ende der *Crista tibiæ anterior externa*.

"I. Häufig sind der *Ilio-tib.* und der *Sartorius* mehr oder weniger mit einander verwachsen, so besonders bei *Pterocles*, *Columbæ*, manchen *Coccygomorphen* (*Rhamphastus*, *Podargus*). Bei *Steganopoden*, *Lariden*, *Alken*, und *Chauna* hingegen ist der *Ilio-tib.* vom *Sartorius* durch eine grosse Lücke getrennt; diese ist natürlich hauptsächlich dadurch hervorgebracht, dass entweder der *Sartorius* nur mit geringer Ausdehnung vom Ilium entspringt, oder dass der *Ilio-tibialis anterior* sich auf den dem Acetabulum näheren Theil des Ilium beschränkt. Auch bei den *Lamellirostren* und den Sumpfvögeln bleiben beide Muskeln meistens getrennt.

"Am weitesten nach vom reicht der *Il.-tib.* bei *Colymbus*, denn er entspringt ausser von dem ganzen Iliumknorren auch noch von den Dorsalfortsätzen der letzten drei Rückenwirbel, auch inserirt er nicht am *M. femoro-tibialis*, sondern direct an der Basis der Aussenkante der hohen *Crista tibio-patellaris*. Hingegen fehlt der *M. ilio-tib. anterior* ganz bei *Phœnicopterus*. Ganz frei und bandförmig ist er bei *Bucorvus*, entspringend vom Vorder- (proximal) Rande des Ilium.

"Ganz allgemein ist der *Ilio-tib.* an seinem Hinterrande mit dem Mitteltheile, dem *Tensor fasciæ*, verwachsen, doch lässt er sich bei manchen Sumpfvögeln, wie *Grus*, *Crex*, *Numenius* leicht davon trennen.

"Bei *Rhea* ist er fast ganz vollständig, und entspringt mit zwei Köpfen. Der eine kommt mit platter Sehne zusammen mit dem ventro-distalen Ursprunge des *Sartorius* (siehe dort) vom lateralen Iliumrande, der andere plattsehnig von einem kleinen Theile vor dem *Processus acetabularis*. Beide Köpfe sinde durch eine vom dorsalen Iliumkamme kommende Aponeurose mit einander verbunden.

margin of the pre-acetabular moiety of the ilium, and the concave surface of the bone external to it. In this locality

"II. Der *M. ilio tibialis medius* oder *M. tensor fasciæ.* Diese mittlere Masse ist weniger Variationen unterworfen. Sie beschränken sich auf Reduction des musculösen Theiles, in dem Ursprung und Insertion aponeurotisch werden. Dieser Theil muss aus folgenden Gründen als eigener Muskel betrachtet werden.

"Obgleich der mittlere Theil der Innervation noch zum *M. il.-tib. anterior* gehört, ferner gewöhnlich mit demselben untrennbar vereinigt ist, so ist er doch bei manchen, wie z. B. bei den *Ratiten* vom *Il.-tib. ant.* getrennt, hingegen mit dem *Glut. post.* vereinigt. Dass er in solchen Fällen wirklich in dem als einheitlich erscheinenden *Glut. post.* enthalten ist, wird am sichersten durch die Innervation aus dem Cruralgebiet erwiesen.

"III. *Ilio-tibialis posterior* oder *Glutæus posterior.* Entspringt fleischig vom laterodorsalen Kamm des postacetabularen *Ilium,* und zwar vom grösseren Theile desselben bei den Ratiten, Hühnern, Tauben, *Pterocles,* den meisten Sumpfvögeln, *Ardea, Alectoriden, Phœnicopterus, Lamellirostres, Colymbus, Podiceps, Cuculiden, Rhamphastus, Pici* und *Capitoniden,* und *Passerinen.* Bei *Struthio* und *Casuarius,* ferner bei einigen *Rasores* und bei *Crypturus* reicht er auf die Aussenfläche des distalen *Ischium,* daselbst dann vom *M. caud.-il. flexorius* bedeckt. Sehr klein, mit seinem Ursprunge auf den *Processus acetabularis* beschränkt ist er bei den *Steganopoden, Spheniscidæ,* Alken, Möven, Sturmvögeln, Papageien, Raubvögeln (ausgenommen *Cathartes*), bei *Upupa,* bei den *Coccygomorphen* mit Ausnahme der *Cuculiden, Ramphastidæ* und *Coraciidæ.* Bei den meisten *Coccygomorphen,* ferner bei *Ciconia, Chauna, Sterna,* den Eulen, und manchen Papageien ist sein Vorhandensein nur dadurch nachzuweisen, dass ein schwacher Nerv aus dem Ischiadicus sich zu der Hinterfläche der den Schenkel deckenden Muskelmasse begiebt. Bei *Buceros* und *Podargus* endlich scheint ein *Glutæus posterior* wirklich ganz zu fehlen."

For an instance of an author considering the entire *gluteus primus* to be the *tensor fasciæ,* we have but to quote the following paragraph of Garrod's from his *Collected Scientific Memoirs,* p. 189. He says :—

"*Tensor fasciæ.*—This is the superficial muscle of the outside of the thigh, covering the femur. It is flat and triangular in shape, and arises as a membranous expansion which covers the gluteus ii., from

it lies immediately beneath the attenuated, anterior portion of the *gluteus primus*.

The fibres of the thick and fleshy muscle thus formed fill in the concavity of the pre-acetabular division of the ilium, converge and pass towards the outer aspect of the proximal extremity of the femur, where they become inserted obliquely upon the trochanter of that bone, by a strong tendon, which rides over a bursa on its anterior rim.

This muscle completely hides from view the *gluteus minimus* which is found beneath it.

96. *The gluteus minimus*[1] is a far smaller muscle

the lower two-thirds of the posterior border of the iliac fossa in which that muscle is situated, and from the fibrous septum which separates that muscle from the gluteus iii. Further down it has origin also from the whole length of the ridge which separates the postacetabular area from the external lateral surface of the ischium, and which may be termed the postacetabular ridge, as well as from the posterior border of the ischium, as far forwards as its junction with the pubis, being here slightly overlapped by the semitendinosus. The fibres converge towards the knee; and the deep portion of the muscle blends in its course with the vastus externus, together with which it continues forward to become part of the broad thin tendon which covers the knee and is inserted in the front of the tibia-head, the patella being situated in it, together with the long, slender, and flat tendon of the *ambiens* muscle, which is situated below it, running obliquely from inside and above, outwards and downwards. In many birds, as the Falconidæ and Psittaci, this muscle does not extend below the level of the femur, but ends inferiorly by blending with the vastus externus; and consequently where such is the case, it evidently cannot, as it does otherwise, cover any of the flexors of the leg. In the Bucerotidæ it is entirely absent. Whether this postacetabular portion of the tensor fasciæ is present or absent has some bearing on classification, as in the different families it is a very constant feature."

[1] I add below the synonymy of the gluteal muscles from Gadow, which will greatly assist the reader in comparing the muscles I describe in the present work as the *gluteus medius* and *g. mimimus*

than the *gluteus medius*, and as I have just said lies immediately beneath it. It makes a semitendinous

with the same muscles as they have been regarded and named by other anatomists.

"30. M. ILIO-FEMORALIS EXTERNUS.

M. tertius femoris. Aldrovandi.
Le muscle pyramidal. Vicq d'Azyr, p. 273, No. 8; Cuvier, p. 503.
Pyramidenförmiger Muskel. Merrem, p. 158, No. 5.
Pyramiden- oder birnförmiger Muskel (*M. pyriformis*). Tiedemann, § 288; Gurlt, p. 27.
Oberer Zwillingsmuskel, oder eigentlicher Auswärtszieher. Meckel, p. 354, No. 4.
Auswärtszieher des Oberschenkels. Meckel, *Archiv*, p. 262, No. 5.
Glutæus externus. Owen, *Apteryx*, p. 290.
,, ,, Selenka, p. 139, No. 75.
,, ,, De Man, p. 120, No. 1.
Glutæus (*maximus*). Quennerstedt, p. 13; Neander, p. 11.
Abducteur supérieur de la cuisse. Milne-Edwards.
M. glutæus anterior. Gadow, No. 21.

"Dieser sehr kleine und flache Muskel ist von dreieckiger Gestalt, und entspringt mit breiter, fleischiger Basis von der Seitenfläche des Ilium in Hohe des Acetabulum. Sein Ursprung erstreckt sich stets bis auf die *Linea dorsalis ilei.* Nach vorn wird er vorn *M. ilio-trochant posterior* begrenzt, den er theilweise bedeckt. Nach hinten grenzt er an den *M. ilio-fibularis.* Er selbst wird vorn *M. ilio-tibialis* bedeckt. Seine platte, ziemlich starke Sehne kreuzt die des *Trochanter externus* oder etwas weiter distalwärts. Der Muskel hält daher hauptsächlich das Femur am Becken fest und zieht es etwas nach aussen."

"29. MM. ILIO-TROCHANTERICI.

"I. *M. ilio-trochantericus posterior.*

M. primus femoris. Aldrovandi.
M. quintus femoris. Steno.
Moyen fessier. Vicq d'Azyr, p. 272, No. 4.
,, ,, Cuvier, p. 500.
,, ,, Gervais et Alix, p. 31.
,, ,, Alix, p. 430.

attachment to the anterior margin of the outer border of the ilium, and has a somewhat more fleshy origin from

Glutæus magnus. Wiedemann, p. 95.
 ,, ,, Tiedemann, § 285.
Glutæus maximus. Gurlt, p. 27.
Mittlerer Gesässmuskel, oder erster Heber des Oberschenkels. Meckel, *System*, p. 352, No. 1; *Archiv*, p. 261, No. 2.
Glutæus medius. d'Alton, p. 32.
 ,, ,, Owen, *Apteryx*, p. 290; *Cyclopædia*, p. 295.
 ,, ,, Selenka, p. 139, No. 76.
 ,, ,, De Man, p. 120, No. 2.
 ,, ,, Quennerstedt, p. 14.
 ,, ,, Neander, p. 10.
 ,, ,, Watson, p. 103.
M. iliacus externus posterior. Gadow, No. 9.

"II. *M. ilio-trochantericus anterior.*

M. secundus femoris. Aldrovandi.
L'iliaque anterieur. Vicq d'Azyr, p. 275, No. 5.
Iliacus minor; kleiner Hüftmuskel. Merrem, p. 159.
Iliacus anterior. Wiedemann, p. 95.
Glutæus medius. Tiedemann, § 286; Gurlt, p. 27.
Vorderer oder Kleiner Gesässmuskel (pt.). Meckel, *System*, p. 353, No. 2.
Zweiter Heber des Oberschenkels. Meckel, *Archiv*, p. 261, No. 3.
Petit fessier. Cuvier, p. 503.
 ,, ,, Gervais et Alix, p. 31.
 ,, ,, Alix, p. 430.
Glutæus alter s. minor. d'Alton, p. 32.
 ,, ,, ,, (pt.). Owen, *Cyclopædia*, p. 295.
Glutæus minimus. Owen, *Apteryx*, p. 291.
 ,, ,, Selenka, p. 140, No. 77.
 ,, ,, De Man, p. 120, No. 3.
 ,, ,, Watson, p. 103.
Glutæus minor. Quennerstedt, p. 12.
 ,, ,, Neander, p. 10.
M. iliacus externus anterior. Gadow, No. 11.

"III. *M. ilio-trochantericus medius.*

M. tertius femoris. Aldrovandi.

the supero-external surface of the last rib, which is seen to be immediately beneath it. From these two points its fibres are directed backwards, downwards, and outwards, slightly converge, then become tendinous, and are finally inserted into the outer aspect of the upper third of the femur, below the trochanter, between the two bellies of the *extensor femoris.*

Professor Owen, after completing his description of the three gluteal muscles in the Apteryx, says further that, "A muscle, which may be regarded either as a distinct accessory to, or a strip of, the preceding one [*glutæus minimus*], arises immediately behind it from half an inch of the outer and inferior part of the ilium; its fibres run nearly parallel with those of the *glutæus minimus,* and terminate in a thin flat tendon, which similarly bends round the outer part of the femur, to be inserted into the outer and under part of the trochanter immediately below the tendon of the *glutæus medius.* This muscle and the preceding portion, or *glutæus minimus,* are described by Professor Mayer under the

Petit fessier. Vicq d'Azyr, p. 273, No. 6.
Glutæus minimus. Tiedemann, § 287.
Vorderer oder Kleiner Gesässmuskel (pt.). Meckel, *Archiv,* p. 261, No. 4.
Glutæus minor. Owen, *Cyclopædia,* p. 295.
Accessory to the glut. minim. Owen, *Apteryx,* p. 291.
Glutæus quartus. Owen, *Comp. Anat.,* ii. p. 100.
,, ,, Selenka, p. 140, No. 77.
,, ,, De Man, p. 120, No. 3.
M. iliacus externus medius. Gadow, No. 10." (Bronn's *Klassen,* vi. Bd. pp. 140, 141.)

Note.—This synonymy must be taken with some degree of caution, for I find it wrong in several instances; as, for one example, Owen does not call the muscle *glutæus quartus* in vol. ii., p. 100, of his *Comp. Anat. of Verts.,* and Selenka is also misquoted for the *g. minimus* (see Bronn's *Klassen,* vi. Bd. p. 140).—R. W. S.

names of *glutæus quartus* and *glutæus quintus*, in the Cassowary; one of them is absent in most birds" (*Anat. of Verts.*, vol. ii. pp. 100–101).

The two smaller gluteals pull the thigh-bone forwards while at the same time they abduct it.

The group of gluteal muscles are also powerfully developed in our *Geococcyx californianus*. In it "the

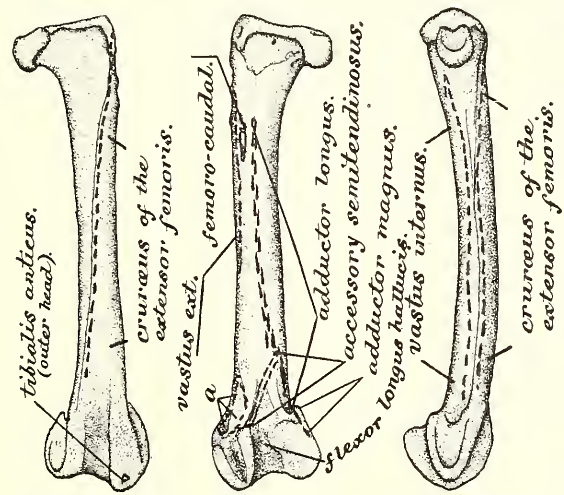

Fig. 45. *Fig. 46.* *Fig. 47.*

FIG. 45.—Anterior aspect of left femur of a Raven, designed to show the muscles that are attached to it.

FIG. 46.—The same bone seen from behind; *a*, femoral head of the *flexor perforans digitorum profundus*.

FIG. 47.—The same bone viewed from its inner side. All life-size, by the author, from his own dissections.

gluteus primus (Fig. 62 *bis*) constitutes that great and rather complex muscle which makes up the central fleshy portion of the outer aspect of the thigh. It arises by a strong fascia from the summit of the co-ossified neural spines of the anterior sacral vertebræ, and by carneous fibres from the outer rim and under surface of the

whorl-like, overarching portion of the ilium behind; and finally from the contiguous portion of the pelvis over the antitrochanter, between these anterior and posterior origins. In front the muscle consists first of a strong layer of semitendinous fascia, which closely overlies the *gluteus medius* muscle beneath it, and overlaps the sartorius anteriorly. The posterior origin and mid-division become rapidly carneous and more massive as we proceed in the direction of the caudal extremity of the body. So that, where we find it arising from beneath the overarching part of the ilium behind, the muscle fills about one-fourth of the convexity there formed, the *semitendinosus* filling the remainder of this curious cavity. The fibres of the strong, semitendinous, muscular sheet springing from these several origins, or rather along this continuous line of origin, now pass, converging as they do so, towards the anterior aspect of the knee-joint. The semitendinous portion anteriorly becomes fleshy as it arrives along the outer pelvic margin, with which it is quite intimately connected. The hinder division of the muscle remains thick and carneous until it comes to the knee-joint. Here all the fibres again become tendinous and fascia-like, and, uniting with a similar structure contributed by the *extensor femoris* lying beneath it, the combined sheath thus formed surrounding the well-developed patella, closely invests the front and sides of the knee-joint, and is finally inserted all round the anterior and externo-lateral borders of the summit of the tibia.

"The *gluteus medius* muscle (Fig. 63 *bis*) is found to be strong and tendinous. It, as in all of the birds that I have examined, fills the concavity of the pre-acetabular portion of the pelvis, and here in *Geococcyx* extends laterally much beyond the bone, as this bird has a very

narrow pelvis anteriorly, while it demands the use of a powerful set of gluteal muscles.

"The *gluteus medius* arises by a strong, flat tendon from the superior surface of the outer moiety of the anterior iliac margin, by a dense fascia from the entire line bounding the pre-acetabular concavity, and finally by fleshy fibres from the upper side of the ilium itself. The fibres of the roundish muscle thus formed converge as they pass to the caput femoris, and, just before arriving at the bone, they terminate in a dense flat tendon, which, passing over a bursa, is inserted at a point on the antero-external aspect of the femoral trochanter.

"The *gluteus minimus* (Fig. 63 *bis*) is a very much smaller muscle than the *gluteus medius*, and is found immediately beneath it to its outer side. In form it is oblong, and fully three times as long as wide. It arises from the outer superior surface of the fore-part of the ilium, and passing obliquely downwards and backwards as a flat narrow band of fibres, it becomes inserted by semitendinous ones on the outer aspect of the upper third of the femur, just below the trochanter. This muscle may also ride over a small bursa, just before it arrives at its insertion" (the present writer in *Proc. Zool. Soc. of London*, 1886; see 120 of *Bibliography* at end of this volume).

97. *The extensor femoris*[1] constitutes the great extensor of the leg upon the thigh.

[1] Bearing upon the nomenclatural history of the *extensor femoris* and *vasti* muscles we have the following from Gadow's work in Bronn's *Klassen des Thier-Reichs* (vi. Bd. pp. 154, 155):—

"35. M. FEMORI-TIBIALIS.

"Der I. und II. Theil.

M. secundus tibiam movens. Aldrovandi.

M. sedecimus femoris. Steno.

It is distinctly divided into two well-defined portions, viz. the *vastus externus* and the *cruræus*. That part

Le muscle crural (*Vaste externe et interne.*) Vicq d'Azyr, p. 276, No. 1.

Innerer grosser Muskel. Merrem, p. 159, No. 2.

Cruralis oder eigentlicher Schenkelmuskel. Wiedemann, p. 95.

M. cruralis cum vasto externo et interno. Tiedemann, § 297.

Unterschenkelstrecker. Meckel, *System*, p. 368, No. 7.

Tiefer Unterschenkelstrecker mit dem äusseren grossen Oberschenkelmuskel. Meckel, *Archiv*, p. 268, No. 3 u. 4 ; p. 269, No. 6 u. 7.

Le triceps crural. Cuvier, p. 523.

Extensor cruris anterior. d'Alton, p. 34.

Rectus femoris et vastus externus. Gurlt, p. 26.

Cruræus et vastus externus. Owen, *Cyclopædia*, p. 296 ; Selenka, p. 144, No. 89 ; De Man, p. 127, No. 15.

Cruræus. Owen, *Apteryx*, p. 293.

Cruralis et vastus externus. Quennerstedt, p. 28.

,, ,, ,, Neander, p. 18.

M. femoro-tibialis. Gadow, No. 17.

Extensor cruris. Watson, p. 115.

" Der III. Theil.

M. quintus tibiam movens. Aldrovandi.

M. sepdecimus femoris. Steno.

Le droit interne (?). Vicq d'Azyr, p. 278, No. 4.

Hinterer grosser Muskel (?). Merrem, p. 159, No. 3.

Rectus femoris internus. Wiedemann, p. 98.

,, ,, ,, Tiedemann, § 298.

Gracilis, oder innerer gerader Schenkelmuskel. Meckel, *System*, p. 367, No. 6 ; *Archiv*, p. 269, No. 5.

Vastus internus. Owen, *Apteryx*, p. 294.

,, ,, De Man, p. 128, No. 16.

,, ,, Quennerstedt, p. 30.

,, ,, Neander, p. 19.

,, ,, Alix, p. 436.

Crural interne. Gervais et Alix, p. 31. Alix.

M. rectus femoris internus. Gadow, No. 16.

Gracilis. Watson, p. 115."

Note.—I believe parts I. and II. here represent my *cruræus* and *vastus externus*, while part III. represents my *vastus internus* (which see), No. 98

which seems to be the homologue of the *vastus externus* arises by a tendon on the outer aspect of the shaft of the femur, at the base of the trochanter, and by fleshy fibres adown the same side of that bone, nearly to the condyle.

The *cruræus* has a bulk fully double the size of the *vastus externus*; it arises by a tendon from the anterior and prominent rim of the trochanter above, and by coarse, somewhat individualized bundles of muscular fibres, down the antero-external aspect of the shaft of the femur. These two muscles and the *gluteus primus* merge below with each other and into that tendinous fascia which spreads over the front of the knee-joint to be inserted into the cnemial crest of the tibia, the fascia of the muscles at the outer side of the leg, and has in it (in its usual position when present, as it is here in the Raven) the well-developed patella.[1]

[1] The *gracilis* muscle does not occur in the Raven, but as the *ambiens* it received no little attention at the hands of Garrod and Forbes, the former anatomist using it extensively in his classification of birds.

Mr. Forbes described the ambiens in the following words. He said :—

"This muscle, unlike the others to be subsequently mentioned, lies on the lower or inner surface of the thigh. As generally developed, it is a more or less slender fusiform muscle, which, arising from the præpubic spine or process of the pelvis, close in front of the acetabulum, runs along the inner side of the thigh superficially, and then, running slightly outwards, runs, as a thin tendon, in the fibrous tissues covering the knee-joint (in some cases perforating the *patella*) to the outer side of the leg, and terminates there by joining one of the tendons of the superficial flexor of the toes, the *flexor perforatus digitorum*. The course of this muscle will be made clear by the accompanying representation of it, as seen in a Touraco (*Corythaix erythrolopha*). In one or two cases (*e.g.*, *Œdicnemus*,

In *Geococcyx californianus* the *ambiens* is conspicuously developed.

It arises from the apex of the prominent prepubic spine of the pelvis, and the fibres passing directly down to the inner side of the femur, and parallel with that bone, form a strong fusiform muscle. As it approaches the patella it terminates in a small flattened tendon, which, piercing the fascial envelope of the knee-joint below the inferior apex of that sesamoid, passes round the joint, to become finally lost to the outer side and opposite the summit of the tibia, where some of its tendinous fibres merge with the fibres of origin of the *flexor perforatus digitorum*, or, at least, with one of its divisions.

The *ambiens* is overlain by the *sartorius* muscle, and in the figure is brought into view only through the aid of a small dissecting-hook and chain, which pull it forwards in order that it may be better seen (see Fig. 64 *bis*).

98. *The vastus internus* is a very distinct and well-defined muscle in the Raven, as it is in a number of other birds.

Stringops) it tends to become obsolete after reaching the knee, becoming lost in the capsule of the knee-joint. In all Passerine birds, and some others, it is always absent" (*Coll. Scientific Papers*, London, 1885, p. 195).

Several centuries ago Aldrovandi in his writings called the ambiens muscle the *m. tertius tibiæ;* it was the *m. quindecimus femoris* of Steno, and the *le crural grêle* of Vicq d'Azyr. Blasius, as well as Merrem, termed it the "Langer Beinmuskel," while it was the *gracilis* of Wiedemann, Tiedemann, Owen, Gurlt, Gegenbaur, De Man, Selenka, Quennerstedt, Watson, and Neander. Cuvier and Meckel had long French and German names for it respectively, and it would seem that it received its present accepted name of the *ambiens* from Sundervall in 1855.

It arises from a point just below the head of the femur on the postero-internal aspect of the shaft, and is attached down the bone in a straight line, increasing in width as it nears the knee, as low as the internal condyle. It then clears the joint to become inserted as a rather broad tendon along the thickened inner border of the summit of the tibia. This muscle is pointed above, and its fibres

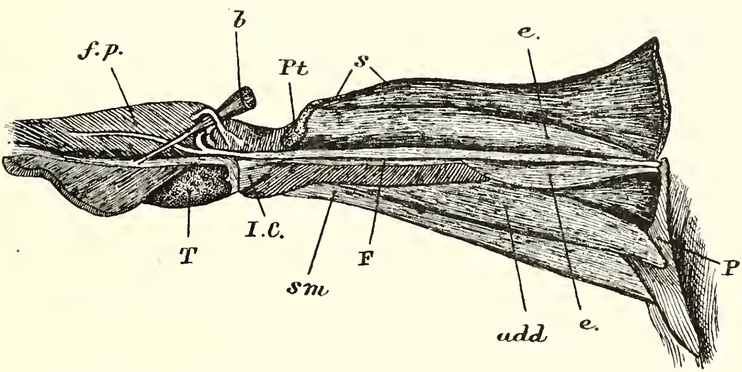

FIG. 48.—Thigh of Touraco (*Corythaix erythrolopha*) viewed from the inner side, to show the ambiens muscle, arising from the præpubic spine of the pelvis (P), and running along to blend with one of the tendons of origin of the flexor perforatus digitorum (*f.p.*). F, femur ; *Pt*, patella ; I.C., inner condyle of femur ; T, tibia ; *b*, biceps (cut short) ; *s*, sartorius (also cut) ; *e*, *e*, extensor femoris ; *sm*, semimembranosus ; *add*, adductores. N.B.—The surrounding parts have been somewhat distorted from their natural positions to show better the course of the ambiens. (By the author, after Forbes.)

diverge as they descend, thus forming a subconical muscular mass, which stands out prominently from the femoral shaft. The lower and outer aspect of the muscle is tendinous, which tendon in passing down merges with its tendon of insertion into the tibial head.

The *vastus internus* also constitutes one of the extensors of the leg upon the knee, and is a powerful auxiliary to the *extensor femoris*.

99. *The biceps flexor cruris*[1] is a single-headed muscle among birds, as it is here in the Raven. It constitutes the principal one of those muscles holding the more anterior position in the group at the back of the thigh. It arises beneath the *gluteus primus* by a tendinous fascia from the postacetabular ridge, extending between the antitrochanter and the anterior point of insertion of the semitendinosus. In form this muscle is flat and triangular, the fibres converging as they descend towards the knee.

All of this group of rear-thigh muscles lie in a plane or planes roughly parallel to the median, longitudinal plane of the body. After passing the knee-joint the

[1] Extraordinary it surely is to find the number of names that this muscle has received at the hands of anatomists, inasmuch as it is easily distinguished, and possessed of peculiar characters. No two writers out of a dozen have given it the same name, and Gadow has given the subjoined synonymy for it (Bronn's *Thier-Reichs*, vi. Bd. p. 168): —

"39. M. ILIO-FIBULARIS.

M. octavus tibiam movens. Aldrovandi.
Biceps. Vicq d'Azyr, p. 277, No. 3.
,, Cuvier, p. 523; Quennerstedt, p. 25.
,, Neander, p. 16; Selenka, p. 143; De Man, 126, No. 12.
Zugespitzter Wadenbeinmuskel. Merrem, p. 159, No. 5.
Flexor cruris anterior. Wiedemann, p. 96.
Flexor cruris primus anterior. Tiedemann, § 299.
Aeusserer oder Wadenbeinbeuger. Meckel, *System*, p. 361, No. 2; [and] *Archiv*, p. 271, No. 10.
Flexor cruris fibularis. d'Alton, p. 34.
Caput breve bicipitis femoris. Gurlt, p. 34.
Biceps flexor cruris. Owen.
Pulsator. Sundevall.
Biceps femoral. Gervais et Alix, p. 32.
,, ,, Alix, p. 440.
Biceps cruris. Garrod.
Biceps femoris. Watson, p. 112.
M. ilio-fibularis. Gadow, No. 27."

muscular part of the biceps is superseded by a strong, round tendon, which, passing down between the muscles of the fleshiest part of the upper and outer side of the leg, becomes attached to a tuberosity on the external aspect of the shaft of the fibula, about two centimetres below its head.

Thus this muscle becomes a powerful flexor of the leg upon the thigh, but it has associated with it another contrivance, so that when the leg is flexed the weight of the posterior moiety of the body is in part transmitted to the lower third of the femur.

This contrivance consists in a tendinous loop, the longer and at the same time the inner end of which is attached just above the outer condyle of the femur, while the shorter end merges with the fascia of the supero-median aspect of the outer head of the gastrocnemius, and the deeper muscles immediately beneath it. The tendon of insertion of the biceps passes through the bight of this exquisite little arrangement, and, in addition to the use already assigned to it, as Owen says, it enables the biceps to effect a more rapid and extensive inflection of the leg than it otherwise could have produced by the simple contraction of its fibres.

Coming to consider these muscles (the *biceps flexor cruris*, *vastus internus*, and the *extensor femoris*), in such a form as *Geococcyx californianus*, I have elsewhere remarked that "the *biceps flexor cruris* (Fig. 63 *bis*) arises by carneous fibres upon quite an extensive portion of the under surface of the over-curled part of the ilium behind the acetabulum, and by a long tendinous slip which comes off from the free anterior margin of this part of the ilium. The fibres converge as they pass downwards, and unite to form a somewhat flattened muscle. Opposite the head of the tibia, the biceps terminates in a round tendon, of

cord-like dimensions, which passes through a special loop to make its way between some of the muscles at the back of the leg, to become inserted on the tubercle intended for it on the outer side of the superior moiety of the shaft of the fibula. The loop of the *biceps* is flat and fashioned like a delicate tendinous ribbon. Its upper end arises from the side of the shaft of the femur above the external condyle, while the lower end comes off from this protuberance just below the insertion of the outer slip of the external head of the *gastrocnemius* muscle. A branch of the sciatic nerve also passes through this loop in company with the tendon of the *biceps*.

"The *extensor femoris* is readily divisible at its lower half into two parts, the bulkier anterior one representing the *cruræus* (Fig. 63 *bis*), and the posterior division the *vastus externus*.

"As a whole, this powerful extensor of the leg upon the thigh arises from the antero-external aspect of nearly the entire length of the shaft of the femur, and from a portion of the trochanter at its summit. At about its lower fourth it terminates in a broad tendinous expansion, which, as has already been described, is amply reenforced by the tendon of the *gluteus primus*, which is situated on the upper side; the combined tendon thus formed surrounds closely the anterior aspect of the knee-joint, and is finally inserted into the proximal end of the tibia, upon its front and external margins.

"The *patella* is found encased in front in this great tendinous sheath of the knee-joint, and below the apex of this sesamoid we find the enveloped track of the tendon of the *ambiens* muscles, as it passes round in front of the femoro-tibial articulation. The combined tendon of the *extensor femoris* is finally inserted into

the cnemial crest of the tibial and the lateral boundaries of the summit of that bone. Some of the superficial muscles on the outer side of the leg are so extended as to take a certain amount of their origin from this great tendinous expansion.

"In (Fig. 63 *bis*) I have very thoroughly divided these two subdivisions of the *extensor femoris*, in order to show their relative size, as well as their relation to each other and the surrounding structures."

100. *The semitendinosus* [1] is a broad and flat muscle, which, aided by the *semimembranosus* beneath it, forms

[1] For interesting accounts of this muscle as it is found in others of the class, see Selenka's myology of Aves (Bronn's *Thier-Reichs*, vi. Bd. p. 143), and Gadow's excellent chapter on the same subject (*loc. cit.*, pp. 162, 164). The latter writer has called it the *Caud.-ilio-flexorius*, and both Selenka and Gadow have treated the "*M. accessorius semitendinosi*" under the same muscle; the last-named is No. 101 of the present work. As heretofore, I republish the synonymy of the *semitendinosus* from Gadow :—

"37. M. CAUD-ILIO-FLEXORIUS.

M. sextus tibiam movens. Aldrovandi.
M. tertius femoris. Steno.
Le muscle qui tient la place du demi-membraneux ou du demi-nerveux. Vicq d'Azyr, p. 277, No. 2.
Hinterer Anzieher des Beines. Merrem, p 159, No. 4.
Flexor cruris posterior. Wiedemann, p. 96.
Flexor cruris tertius s. posterior. Tiedemann, § 301.
Le muscle demi-nerveux. Cuvier, p. 524.
Schienbeinbeuger. Meckel, *System*, p. 362, No. 3; *Archiv*, p. 269, No. 8.
Semitendinosus. Owen.
" Selenka, p. 143.
" De Man, p. 126, No. 13; Quennerstedt, p. 26.
" Garrod; Watson, p. 113.
Demi-tendineux. Gervais et Alix, p. 32.
" Alix, p. 441.
M. caudi-ilio-flexorius. Gadow, No. 25."

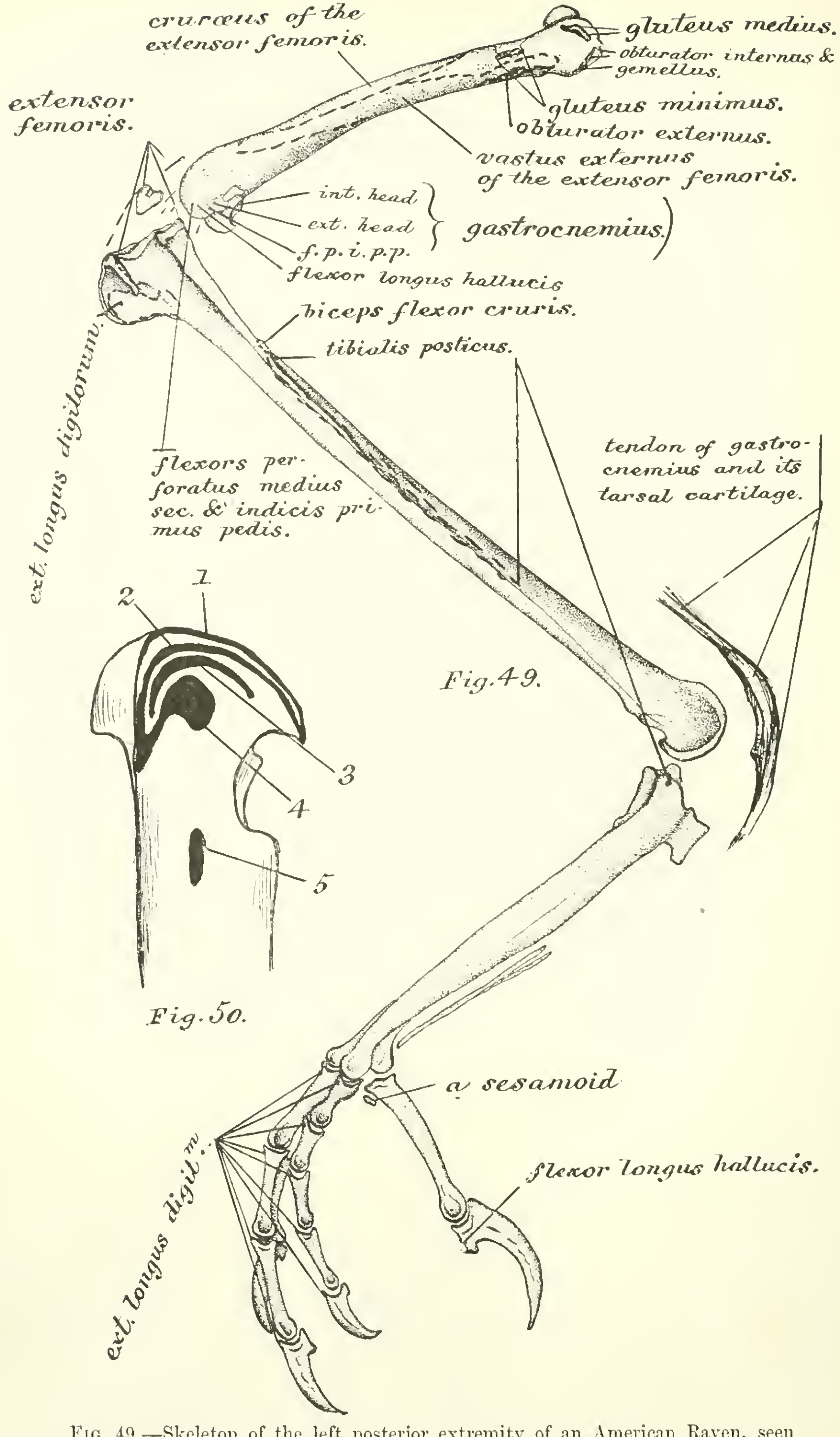

FIG. 49.—Skeleton of the left posterior extremity of an American Raven, seen from the outer side. Drawn by the author from his own dissections,

and designed to show the origin and insertion of a number of the muscles of the hind limb. *f.p.i.p.p.*, *flexor perforatus indicis primus pedis.*

Fig. 50.—Sketch of anterior aspect of the head of the tibia of the same specimen, enlarged; showing insertions of the muscles there found. 1, the *extensor femoris*; 2, *peroneus longus*; 3, *tibialis anticus* (inner head); 4, *extensor longus digitorum*; 5, separate slip from *extensor longus digitorum.*

behind the muscular contour of the thigh. It arises from the hinder third of the postacetabular ridge, and by a thin, though strong, fascia from the surface of the caudal muscles beneath it. Its fibres pass obliquely downwards and forwards to become inserted into the tendinous raphe which is found along the posterior truncate margin of the *accessory semitendinosus*, the lower point of which raphe merges with the median fascia of the inner head of the *gastrocnemius* muscle.

So far as I can ascertain from anatomical works at present available, the origin of the *semitendinosus* in the Raven seems to be, at least, quite an uncommon one. Owen, speaking of it for the Apteryx says, it "arises from the posterior and outer part of the sacrum and the aponeurosis connecting it with the ischium;" while Forbes, describing it more generally for the class, says that "it arises from the transverse process of the first free coccygeal vertebra, and from the fibrous membrane between this and the ilium." Indeed, we have yet much to investigate in the myology of this group of vertebrates!

101. *The accessory semitendinosus* is a flat oblong muscle that arises from an oblique line just above the condyles, on the posterior aspect of the shaft of the femur (Fig. 46). Its fibres, passing directly upwards and backwards, attach themselves to the tendinous raphe common to this muscle and the *semitendinosus*, already described in the preceding paragraph.

In the Raven the *accessory semitendinosus* has a

length of something over two centimetres, with a corresponding width of about one centimetre, while in thickness it does not exceed twenty-five millimetres. The raphe is continued on, as a slender tendon, to the inner side of the shaft of the tibia, where it becomes inserted.

102. *The semimembranosus*[1] (Figs. 24 and 50) also contributes to the contour of the posterior line of the fleshy part of the thigh in the Raven. It is a long, narrow, somewhat ribbon-like muscle, that arises from the outer surface of the ischium of the pelvis, from the lower margin of its notch on the posterior pelvic border and extending on a curved line on the surface beyond,

[1] As is well known, this is another muscle that Garrod describes in his chapter on the value of muscles in classification, although this one was but little used owing to the fact that it is quite constant in the class.

Gadow, who well describes it, gives us the following synonymy (*loc. cit.*, p. 166) :—

"38. M. ISCHIO-FLEXORIUS.

M. septimus tibiam movens. Aldrovandi.
M. quatuordecimus femoris. Steno.
Demi-nerveux (?). Vicq d'Azyr, p. 277, No. 3 (pt.).
Biceps (pt.). Vicq d'Azyr, 1774, p. 507, No. 3.
Kleiner Lendenmuskel (?). Merrem, p. 158, No. 4.
Flexor cruris tertius. Wiedemann, p. 97.
Flexor cruris quartus. Tiedemann, § 302.
M. demi-membraneux. Cuvier, p. 523.
Ohne Namen. Meckel, *System*, p. 364, No. 4 ; *Archiv*, p. 270, No. 9.
Flexor cruris tibialis. d'Alton, p. 34.
Semimembranosus. Gurlt, p. 29 ; Selenka, p. 144.
,, ,, (pt.) Quennerstedt, p. 27.
,, ,, (pt.) Neander, p. 17.
,, ,, De Man, p. 127, No. 14; Garrod; Watson, p. 113.
Le droit interne. Gervais et Alix, p. 32.
,, ,, Alix, p. 442.
M. ischio-flexorius. Gadow, No. 26."

as shown in Fig. 24. From this origin this straight muscle passes directly downwards and forwards, and when it arrives at the muscles of the leg, it becomes converted into a delicate, thin tendon which, passing between the muscles of these parts, reaches the inner side of the shaft of the tibia about one and a half centimetres below its head, or rather bounding line of its summit, where it is inserted on a line parallel with the long axis of the tibial shaft (Fig. 50).

The *semimembranosus* is a direct flexor of the leg upon the thigh; it lies nearly in the same plane with the *semitendinosus*, the contiguous borders being joined by the surrounding connective tissue.

Mr. Garrod says of these last three muscles that "some birds, as in the Eagles and Owls, have no semitendinosus at all; some, as the Anserine birds and Penguins, have no accessory semitendinosus, in which case all the fibres go straight to the tibia-head; whilst in most the above-described condition maintains;" and of the semimembranosus he remarks that "this muscle is very constant in birds; in the Grebes it is extremely thin, and may sometimes be absent, as stated by Sundevall; but I have seen it in some fresh specimens of *Podiceps minor*, though but very slightly developed" (*Coll. Scientific Memoirs*, London, 1881, p. 190).

And of the same three, as they occur in *Geococcyx*, I said in the *P.Z.S.* of 1886, that the *semitendinosus* (Fig. 64 *bis*) is a marvellously well-developed muscle in this form, as is also its accessory head. Its origin fills about three-fourths of the nether cavity formed by the posterior overarching portion of the ilium, under which it arises.

Posteriorly, the fibres forming its free margin are so arranged as to create a rounded border; the lower end

of its arc terminating about opposite the post-pubis of the pelvis. From this origin the fibres of the *semitendinosus* pass downwards and forwards as a great, though somewhat compressed muscle. When within rather more than a centimetre's length of the shaft of the femur, they terminate in an oblique tendinous raphe, which latter forms the bounding-line between this muscle and the next.

The *accessory semitendinosus* (Fig. 64 *bis*) is composed of coarser fibres than the muscle just described. It springs from a longitudinal line occupying the distal half of the shaft of the femur, and from the upper surface of the hinder aspect of the external condyle of that bone. The fibres pass backwards and a little upwards to become inserted into the tendinous raphe just alluded to.

The lower extremity of this tendinous raphe terminates, in *Geococcyx*, in a thin, flat, and delicate tendon, which continues downwards and forwards to the inner surface of the head of the tibia, where it becomes inserted, the point of insertion being found above that of the *semimembranosus* muscle, the insertional tendon of which overlaps it.

The *semimembranosus* (Fig. 64 *bis*) in *Geococcyx*, though thoroughly developed, is rather a slender and thin muscle, markedly so when we compare it with the massive *semitendinosus* which overlies it.

It arises from the outer surface of the ischium, for its posterior two-thirds, on a line situated a few millimetres above the lower free edge of that element of the pelvis. The fibres gradually converge as they pass downwards and forwards, to terminate in a very delicate and thin ribbon-like tendon, which, passing between the broad tibial head of the *gastrocnemius* and the proximal

extremity of the shaft of the tibia, becomes finally thereupon inserted on its internal surface. The hinder margin of the *semimembranosus* is free, while its border anteriorly is juxtaposed to the posterior edge of the adductors.

103. *The femoro-caudal*[1] is another one of that group of five or six muscles made historical through the

[1] Gadow has carefully gotten together quite a complete synonymy of this muscle for us, which shows, in the most interesting way possible, the various christenings it has been at various times subjected to. I reproduce this synonymy here, it being from the work so frequently quoted throughout the present treatise :—

"36. M. CAUD-ILIO-FEMORALIS.

M. sextus femoris. Steno.
Le deuxième abducteur de la cuisse; M. cruro-coccygien. Vicq d'Azyr, p. 278, No. 3.
Schwanzhüftmuskel. Merrem, p. 158, No. 2.
M. cruro-coccygeus + Adductor primus femoris. Wiedemann, p. 96 u. 98.
Adductor primus femoris + Cruro-coccygeus. Tiedemann, § 225 u. § 290.
Birnmuskel. Meckel, *System*, pp. 355--357, No. 5.
Birnenförmiger Muskel. Meckel, *Archiv*, p. 263, No. 8.
Le fémoro-caudien du cruro-coccygien. Cuvier, p. 288, No. 8.
Gemellus superior + inferior. Gurlt, p. 20 u. 27.
Adductor longus femoris. Owen, *Apteryx*, p. 291.
Abaisseur supérieur de la cuisse. Milne-Edwards.
Triceps adductor femoris (third head). Reid, p. 143.
Femoro-caudalis + Caput pelvinum m. femoro-caudalis. Sundevall.
Adductor longus. Selenka, p. 141, No. 81.
,, ,, De Man, p. 123, No. 8.
Femoro-caudal + Accessory-femoro-caudal. Garrod.
Femoro-coccygien. Gervais et Alix, p. 32.
,, ,, Alix, p. 433.
M. caudi-ischio-ilio-femoralis. Gadow, No. 24.
Adductor longus femoris + Cruro-coccygeus. Watson, p. 105.
Hierzu Kommen noch die kleinen Hülfsmuskeln, in der Literatur meistens ohne Namen.

numerous dissections of the thighs of birds by the genius of Garrod.

In the Raven, as in so many of the class, it is, next to the *biceps cruris*, one of the most interesting muscles that our scalpel reveals for us.

In form it is a long narrow spindle, flattened from side to side. Its caudal extremity is drawn out into a delicate tendon, which, arising from the base of the pygostyle of the tail-skeleton, passes between the lateral caudal muscles towards its insertion.

Its anterior extremity is also tendinous, but thin and flattened in the same plane with the muscle. This is inserted upon the outer aspect of the shaft of the femur, below the trochanter, at about the junction of the upper with the middle third of the bone. With the limb fixed, and the muscle acting from its femoral end, it would assist the lateral caudal muscles in drawing the coccyx, and with it the tail, to its own side; but with the coccyx fixed, it would, in contracting from that end, tend to pull the femur backwards and slightly rotate it outwards.

In describing the origin and insertion of this muscle for the class generally, Garrod says that "it arises from the (anterior) transverse processes of the two last coccygeal vertebræ, and is inserted into the linea aspera of the femur, at about one-third its length from the trochanter." The fact that it arises from the base of the pygostyle (Fig. 24) in our present subject forms quite an interesting exception to the general rule as laid down by the talented anatomist just quoted.

Ohne Namen. Meckel, *System*, p. 356, No. 5, und p. 357, No. 7; *Archiv*, p. 265, letzter Absatz vor No. 10, und p. 262, No. 6.
M. quadratus femoris; Adductor brevis. Owen, *Apteryx*, p. 292, 291." (Bronn's *Klassen des Thier-Reichs*, vi. Band. p. 158.)

It may be as well to observe that the point of insertion of this muscle upon the shaft of the femur is some little distance below that of the *gluteus minimus*; the *vastus externus* of the *extensor femoris* passes up between these two muscles, and the *femoro-caudal* itself overlies the adductor muscles which pass down between it and the pelvis; so that its insertion may also be said to be on a narrow vertical line between the insertions of the *vastus externus* and the adductors.[1]

In my memoir upon *Geococcyx* I said that in that genus "The *femoro-caudal* muscle and the *accessory femoro-caudal* are both present and fully developed.

"The *femoro-caudal* (Fig. 64 *bis*) arises, tendinous, from the lower posterior border of the pygostyle. It soon becomes fleshy, and as a narrow, muscular ribbon passes through the tissues overlying the lateral group of caudal muscles proper. Opposite the posterior border of the pelvis it expands to form a prettily-shaped and compressed spindle, closely covering the *obturator externus* muscle and the side of that bone. As it nears the femur it again contracts, receives the fibres of its accessory head, and is finally inserted upon the femoral shaft, at the posterior aspect of its proximal third.

[1] Many birds have an *accessory femoro-caudal*; it is absent in the Raven. It is described by Garrod as "an accessory head, arising from the upper three-fourths of the postacetabular ridge, and from the ridge which forms the lower margin of the origin of the obturator externus, joins the tendon of insertion of this muscle, and is also partly inserted into the linea aspera, between it and the head of the femur. It is thin, muscular, and broad, covering the obturator externus superficially, and is partially intersected by a fibrous sheet where it crosses its anterior border. The sciatic artery and nerve cross it superficially; and the nerve to the semimembranosus is deep of it, whilst that to the semitendinosus is superficial in some cases; the biceps completely covers it" (*Coll. Scientific Memoirs*, p. 191).

"The *accessory femoro-caudal* (Fig. 64 *bis*) arises beneath the overarching part of the postacetabular portion of the ilium, just behind the acetabulum and beyond. Its fibres pass obliquely downwards and forwards to join with those of the *femoro-caudal*, and to become inserted with them into the upper part of the femur as already described."

104. *The obturator externus*[1] is a thick fleshy muscle that arises from the posterior half of the periphery of the ischiatic foramen and the concavity found on the external surface of the lateral aspect of the pelvis behind it; its boundary above being the postacetabular ridge, while its fascia is nearly carried to the posterior pelvic margin behind (Fig. 24). From this origin it passes directly toward the femur, its fibres converging

[1] The subjoined synonymy is from Gadow, *loc. cit.*, p. 170:—

"40. M. ISCHIO-FEMORALIS.

M. quartus femoris. Aldrovandi.
M. duodecimus femoris. Steno.
Le muscle qui tient la place du quarré. Vicq d'Azyr, p. 273, No. 10.
Rotator femoris. Wiedemann, p. 97.
Obturator externus. Tiedemann, § 289.
,, ,, Watson, p. 107.
Zweiter Niederzieher, oder viereckiger Schenkelmuskel, oder äusserer Hüftbeinlochmuskel. Meckel, *System*, p. 357, No. 6; *Archiv*, p. 265, No. 10.
Le carré de la cuisse. Cuvier, p. 503; Milne-Edwards.
Gemellus superior. d'Alton, p. 32.
Glutæus maximus. Coues, p. 168.
Quadratus femoris. Gurlt, p. 27.
,, ,, Selenka, p. 140, No. 79.
,, ,, De Man, p. 122, No. 6.
Pyramidalis. Owen, *Apteryx*, p. 291; Kuhl, p. 79.
Pyriformis. Quennerstedt, p. 19.
,, Neander, p. 13.
Le carré. Gervais et Alix, p. 32; Alix, p. 432.
M. ischio-femoralis. Gadow, No. 23."

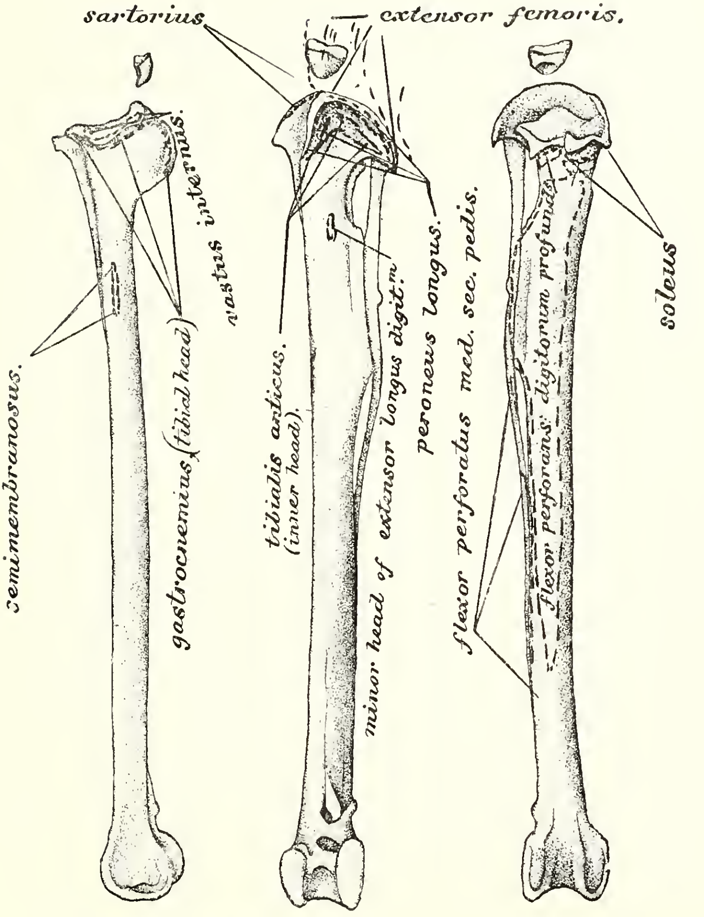

Fig. 51. Fig. 52. Fig. 53.

Fig. 51.—Left tibia and fibula of a Raven viewed from the inner side.
Fig. 52.—The same bones seen from in front.
Fig. 53.—The same from a posterior aspect. Designed to show in each case the origin and insertion of their muscles. In each, the patella is placed in position above the tibia. All the drawings are life-size, from the author's own dissections.

to form a broad, flat tendon, which is inserted into the shaft of that bone just below its trochanter. This insertion is almost directly opposite that of the *gluteus*

minimus, and the *vastus externus* muscle of the *extensor femoris* is inserted on a longitudinal line between them (Fig. 49). In the absence of the *accessory femoro-caudal* as we find it here, the sciatic nerve and artery passes over and external to the tendon of the *obturator externus,* its track being impressed upon it in spirit specimens.

In the course of my remarks on the value of certain of these muscles in the classification of birds, published in another connection (see 124 of *Bibliography*) I said that, "There are *five* muscles in the thigh which have proved to be more or less useful in the classification of birds. These muscles are the following, and four of them I have designated by the letters which were used by Garrod in his myological formulæ.

6. *The ambiens,*
7. *The femoro-caudal* . . . . A
8. *The accessory femoro-caudal* . . . . B
9. *The semitendinosus* X
10. *The accessory semitendinosus* . . . . . . Y

"We know of no bird in which all five of these muscles are absent, or even of one which lacks the last four in the list.

"According to Garrod, 'when these four muscles are present in a bird, the formula AB. XY expresses the fact; when any one is absent, that such is the case is indicated by the omission of the letter representing it. Thus the formula A. XY indicates that the accessory femoro-caudal muscle only is absent; AB. X that the accessory semitendinosus is missing; A.X that the femoro-caudal and semitendinosus only are to be found; and A that the femoro-caudal alone is present.'

"This eminent anatomist applied these myological formulæ to a classification of the entire group of existing birds, and fully discussed the matter in his work in the most masterly manner in so doing, but it will be impossible to enter upon any such field here. In my own opinion, however, I am inclined to believe that Garrod's classification stands in need of a very thorough overhauling in many of its aspects; by this I mean that in a vast number of cases we are not in possession of the requisite knowledge of the *entire structure* of certain forms as to warrant one retaining them where Garrod has placed them. In other words, these myological formulæ, as time goes by, and our knowledge of avian morphology widens, will surely prove very useful in taxonomy, *but* they can only be employed with safety when taken, as *one set of characters*, in connection with *all* the others that the organization of any particular bird-form presents us with, and by no means are we to rely upon them alone, or even when a few other sets of structural characters seem to indicate a bird's affinity.

"To illustrate my point, let us turn for a moment to the Swifts and Humming-birds; here we have two groups which for years past have been associated together as allied forms by systematists, and Garrod, too, seemed to believe in their affinity. Why? Because the formula for the thigh-muscles in each case was found to be A; the sternum had in each case an unnotched posterior border; and neither Swifts nor Hummers possess intestinal cæca. Yes, this all may be so, but *all* the rest of the organization of these birds is as widely different as one can well imagine, and consequently they belong to very different orders of birds. This latter statement gains weight when we come to think that aside from the formula for the thigh-muscles

being the same in *Cypseli* and *Trochili*, their pelvic limbs otherwise are by no means alike in other particulars; and the sternum is, too, of a very different pattern in each case, although, as I say, each possesses an entire posterior xiphoidal margin.

"As in the case with the other muscles described in the foregoing paragraphs, ornithotomists have a fine field open before them in dissecting out this group of thigh-muscles in our United States birds; making full notes upon their researches, and comparing carefully with the work already accomplished by the indefatigable Garrod. In doing this, not merely the absence or presence of the five muscles last described should be noted, but, if possible, full notes made as to their *exact* origins and insertions, their *relative* size as compared with other allied birds, and in short their morphology in its details."

105. *The obturator internus*[1] in the Raven, as in most birds, is a bipenniform muscle which arises from the ventral surface of the ischium, as far back as to include

[1] Cuvier, even so far back as his time, considered this muscle to be the "*obturateur interne*," and with but one or two exceptions, it has universally been so regarded since the earlier works of Owen.

Gadow gives the following synonymy for it, it being his *M. obturator* (*loc. cit.*, 171):—

"41. M. OBTURATOR.

M. quintus femoris. Aldrovandi.
M. decimus femoris. Steno.
L'iliaque interne. Vicq d'Azyr, p. 275.
Iliacus internus. Wiedemann, p. 98.
,, ,, Tiedemann, § 293.
Dritter Anzieher, Einwärtszieher oder Kammmuskel. Meckel, *System*, p. 359, No. 10; *Archiv*, p. 265, No. 11 u. 12.
Obturator interne. Cuvier, p. 503.
Obturatorius. d'Alton, p. 33.

its hinder margin; from the inner line of the corresponding postpubis; and from the membrane filling in the obturator space between these two elements. It is of a subtriangular form, flat, and possesses a central tendon to which its fibres converge in an oblique anterior direction. When this tendon reaches the obturator foramen it becomes dense, subcylindrical, and strong, and passing through this vacuity it is inserted, in common with the *gemellus*, into the outer aspect of the trochanter of the femur, opposite the insertion of the *gluteus medius*. Outside the pelvis the tendon of this muscle lies upon the *gemellus* and is external to it.

The late Professor Garrod made a point of calling attention to the fact as to whether the area covered by the origin of the *obturator internus* was of an oval or a triangular outline, and entered the information in his valuable tables of the anatomical characters of birds. It seems to me, however, that such a character as this must bear with it but very little weight, as the form of the muscle, so far as my observations go, varies directly with the form of the pelvis, and particularly with the form of the osseous elements to which it is attached.

About three years ago, I published an article entitled "A Review of the Muscles used in the Classification of Birds" (see 124 of the *Bibliography* at the end of this

Obturator internus. Owen, *Apteryx*, p. 292; Reid, p. 143; Gurlt, p. 28.
" " Garrod.
" " Quennerstedt, p. 14.
" " Neander, p. 12.
" " Watson, p. 108.
Abducteur interne de la cuisse. Milne-Edwards.
L'obturateur externe. Gervais et Alix, p. 31; Alix, p. 434.
M. obturator. Gadow, No. 19."

volume), in which I made certain remarks upon "the area of the origin of the *obturator internus*." As they bear upon what I have just said in the last paragraph, they will be of value for comparison in the present connection, and so are here republished: this applies more particularly to the figure (53 *bis*), also given, as it represents the parts in question as they occur in that curious bird the Piñon Jay, one of the *Corvidæ* of the western

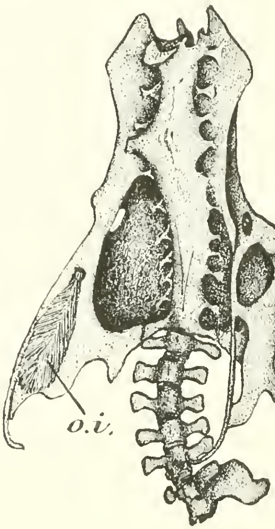

FIG. 53 *bis*.—Right three-quartering view of the pelvis of a specimen of the Piñon Jay (*Cyanocephalus cyanocephalus*), showing the origin of the *obturator internus* muscle of the right side, *o.i.* Drawn by the author from the specimen, and somewhat enlarged.

part of the United States. In the paper to which I have just referred, I said, substantially, of the *obturator internus*, that "In birds this muscle arises, as shown in the figure, from the ventral surface of the pelvis, its fibres being attached to the post-pubic bone and the ischium. As a rule it is a bipenniform muscle, its fibres being directed forwards, but at the same time, on either

side of its own moiety, towards a longitudinal tendinous and mid-line of its own. This tendon becomes stronger as it approaches the obturator foramen, and passing through this, is finally inserted into the head of the femur of the corresponding side, and upon its outer surface.

"Now in a great many birds the area from which the *obturator internus* arises is of an *oval* outline, while on the other hand in nearly an equal number of the class, this area will be found to be a *triangular* figure. So it has been said, that it can thus be utilized as a good character, in this way, when taken in connection with others. In some few birds, I understand, it is difficult to determine whether this area of origin is *oval* or *triangular*, but as a rule no such difficulty presents itself. For my own part it constitutes a difference which, I am free to confess, I had as yet paid but little attention to, as for several years past neither the proper material nor other facilities for such investigations have been available. Nor am I quite sure in my own mind as yet, how far the form of the hinder portion of the pelvis may influence the origin of this muscle; and whether such birds do not exist wherein a large *obturator internus* is demanded, and where their pelves are *short*, in which cases the muscle, to gain a firmer origin, would naturally spread out posteriorly, and thus of necessity become *triangular*.

"But as I say, I am not prepared to pass final judgment on this matter, and render a personal opinion as to whether much reliance can be placed upon it as a useful character in determining affinities among birds.

"Here then again is a field open to decide an important point, and one easily to be understood, and not difficult to render extensive records about. Those living where land and water birds occur in abundance could soon determine whether (or no) this character possessed any

taxonomic value or not, and the result would surely prove of service to ornithology."

106. *The gemellus*[1] is a strong, thick, rather chunky muscle, ensconced between the posterior aspect of the femoral trochanter and the pelvis. It arises from the entire base of that circumscribed fossa found between the acetabulum and the obturator foramen, on the outer side of the pelvis (Fig. 24). Its fibres, attached by fascia to the tendon of the *obturator internus*, pass directly to the trochanter of the femur to be co-inserted with the last-named muscle, to which it plays really the part of an auxiliary. Professor Owen found this muscle in Apteryx as a single, small, fleshy strip, and Mivart says that in some Vertebrates it may be wanting altogether, as it is in the Ornithorhynchus and Echidna (*Elem. Anat.*, p. 342).

The two obturator muscles and the present one are devoted to drawing the pelvis forward, and steadying it on the head of the femur when that bone is fixed.

107. *The adductor longus*[2] is a broad, flat muscle,

[1] Watson followed Owen in regarding the present muscle as the *gemellus;* while others have considered it to be the *obturator externus.* The subjoined synonymy is from Gadow (*loc. cit.*, p. 173):—

"42. MM. ACCESSORII M. OBTURATORIS.

L'accessoire de l'iliaque interne. Vicq d'Azyr, p. 273, No. 9.

Ohne Namen erwähnt. Meckel, *Archiv*, p. 266, No. 13; *System*, p. 350, bei No. 10.

Gemellus. Owen, *Apteryx*, p. 292.

,, Kuhl, *Beiträge*, p. 79; Watson, p. 108.

Obturator externus. Quennerstedt, p. 15.

,, ,, Neander, p. 12.

,, ,, De Man, p. 127, No. 5.

Pyramidal (?). Alix, p. 433.

Mm. accessorii m. obturatoris. Gadow, No. 20."

[2] So distinct are the adductor muscles in the thigh of a Raven, that I felt myself to be correct in describing them as two. Very

composed of rather coarse carneous fibres. It arises from a line on the lateral aspect of the pelvis, which line constitutes the lower boundary of the ischiatic fossa that contains the *obturator externus* muscle. The extent occupied on this line by the *adductor longus* is equal to the length of it between the obturator foramen and a point rather posterior to the ischiatic foramen, in the vertical line. Here it is met by the *adductor magnus*, the anterior point of its origin. By an oversight in Fig. 24, the relative positions of the origins of the *semitendinosus* and the two *adductors* are in each case a little too far forward to agree with what we find in the majority of specimens. This has been corrected, however, in the figures illustrating these muscles, and in the several descriptions.

generally, however, they have been considered as one muscle, and Gadow records the following synonymy for them (*loc. cit.*, p. 174):—

"43. M. PUB.-ISCHIO-FEMORALIS.

M. septimus femoris. Steno.
Le premier adducteur de la cuisse. Vicq d'Azyr, p. 278, No. 2 (nicht *le* deuxième, wie Tiedemann angiebt).
Kurzer Lendenmuskel. Merrem, p. 158, No. 4.
Abductor secundus femoris. Wiedemann, p. 97.
" " " Tiedemann, § 291 (= *adductor magnus hominis*).
Unterer äusserer + innerer Anzieher. Meckel, *System*, p. 358, No. 8 u. 9.
Anzieher. Meckel, *Archiv*, p. 264, No. 9.
Abducteurs (pt.). Cuvier, p. 506; Gervais et Alix, p. 31; Alix, p. 435.
Adductor internus et externus. d'Alton, p. 33.
Adductor femoris longus et add. fem. magnus. Gurlt, p. 28.
Adductor magnus. Owen, *Apteryx*, p. 292.
" " Selenka, p. 141, No. 80.
" " De Man, p. 123, No. 7.
" " Watson, p. 106.
Adductor magnus (et brevis). Quennerstedt, p. 20.
" " " Neander, p. 14.
M. pubo-ischio-femoralis. Gadow, No. 18."

From the origin I have just given for the *adductor longus*, its fibres pass downwards and forwards to be inserted on a longitudinal line adown the posterior

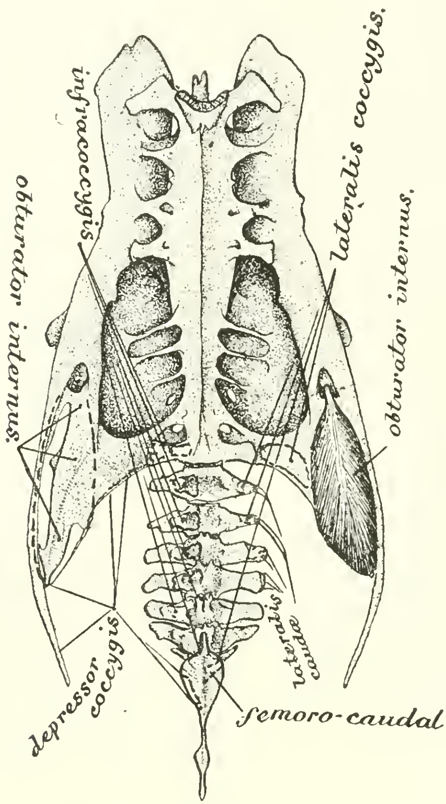

FIG. 54.—The pelvis of a Raven, seen upon its ventral aspect, with the skeleton of the tail. Shows the area of origin of the *obturator internus* muscle, as well as the muscle itself. The origin of the left *femoro-caudal* is also shown. Life-size, by the author, from his own dissections.

aspect of the shaft of the femur (Fig. 46), from a point rather above the insertion of the *femoro-caudal*, all the way to the base of the internal condyle of that bone.

The posterior margin of this muscle is connected to

the anterior margin of the *adductor magnus* by a firm but delicate fascia.

108. *The adductor magnus* is in reality a longer and narrower muscle than the preceding, and is composed of finer and somewhat more compact muscular fasciculæ. It also arises from the line constituting the lower boundary of the ischiatic fossa for the *obturator externus* muscle, on the outer lateral aspect of the pelvis. Its extent of origin on this line commences where the *adductor longus* terminates posteriorly, and occupies rather more than seven millimetres of it in the posterior direction, to a point where the *semitendinosus* terminates anteriorly.

From this origin its fibres pass directly down to the superior curve of the internal femoral condyle, where they are inserted. The internal head of the *gastrocnemius* is largely attached to this muscle just above its insertion; its anterior margin is also attached by fascia, as alluded to above, to the *adductor longus.* In fact both of these adductors lie practically in the same plane, and act as one muscle. We observe also that they develop but very little tendon, either at their origins or their insertions.

Owen found the *adductor magnus* in the Apteryx to be "a broad and flat muscle, which has an extensive origin (two inches) from the outer edge of the ischium and the obturator fascia; its fibres slightly diverge as they pass downward to be inserted into the back part of the lower half of the femur, and into the upper and back part of the tibia" (*loc. cit.*, p. 101).[1]

[1] There are a number of muscles described by Sir Richard Owen for the Apteryx that from one reason or another I have thus far failed to identify with any of those I found in the Raven.

Of these we are to notice the *iliacus internus*, the *pyramidalis*, the *adductor brevis femoris*, and the *quadratus*.

According to this authority, the *iliacus internus* in the Apteryx

Referring to the myology of *Geococcyx californianus* and the four last muscles we have just been considering, we find that the *obturator internus* arises from an oval area, and has much the same origin and insertion as we find it here in the Raven. In *Geococcyx*, too, the *gemellus* (Fig. 65 *bis*) is a short, thick, carneous muscle, which arises about the outer rim of the obturator foramen of the pelvis. Its fibres passing obliquely upwards and forwards are inserted with the tendon of the *obturator internus* muscle on the trochanter of the femur. This bird also has a few of the fibres of its *gemellus* muscle inserted into the tendon of the *obturator externus* muscle,

"is a somewhat short thick muscle, of a parallelogrammic form, fleshy throughout; rising from the tuberosity of the innominatum in front of the acetabulum immediately below the *gluteus minimus*, and inserted at a point corresponding to the inner trochanter, into the inner side of the femur near the head of that bone, which it thus adducts and rotates outwards. This muscle is present both in the Ostrich and Bustard.

"The *pyramidalis* arises fleshy from the outer surface of the ischium for the extent of an inch, and converges to a broad flat tendon, which is inserted into the *trochanter femoris*, opposite, but close to, the tendon of the *gluteus minimus*, which it opposes, abducting and rotating the femur outwards.

"The *adductor brevis femoris* arises from the innominatum immediately behind the acetabulum, passes over the back part of the great trochanter, becomes partially tendinous, and is inserted into the back part of the femur.

"The *quadratus* is a broad fleshy muscle which arises from the pubis, below the *obturator foramen*, and which increases in breadth to be inserted into the femur internal and posterior to the obturator tendon" (*Anat. of Verts.*, vol. ii. pp. 100–102).

Since writing the above notes, I have gone more fully into the literature of the myology of birds, made possible by better facilities, and it will be evident from the synonymy I have added from Gadow throughout this work what some of these muscles of Owen's are; as, for instance, the *pyramidalis* is evidently my *obturator externus*; or No. 40 of Gadow, his *m. ischio-femoralis*.—R. W. S. (June 25, 1889).

at least I found this to be the case in at least one specimen examined by me.

The *adductors* arise from the infero-external margin of the ischium, between the anterior edge of the *semi-membranosus* and the obturator foramen.

The *adductor longus* (Fig. 64 *bis*) is the more anterior of the two, and consequently arises the higher on the pelvis, and comes off in front of the *adductor magnus,* which it largely overlaps. Its fibres pass obliquely to the posterior aspect of the shaft of the femur, down which they become inserted as far as its middle, along the *linea aspera,* a line which is well marked in our subject.

The *adductor magnus* (Fig. 64 *bis*), like the one just described, is also a broad ribbon-like muscle, arising from the ischium between the *semimembranosus* and a middle point on the under side of the *adductor longus,* close up to its semitendinous origin. Anteriorly its margin is free, while posteriorly it is juxtaposed to the anterior border of the *semimembranosus.* Passing parallel with those of the other adductor, its fibres are inserted into the distal moiety of the *linea aspera* of the femoral shaft, down to the intercondyloid notch of that bone, where this muscle makes a very substantial insertion.

Other authorities at my hand have but little to say about the adductor muscles in the thighs of birds.

MUSCULATURE OF THE LEG AND THE REMAINING PARTS OF THE LOWER EXTREMITY.

The preparatory dissection necessary to bring the muscles of these parts into view has already been suggested above.

109. *The gastrocnemius*[1] muscle in the Raven is quite a complicated one, more complicated even than we find it to be in a man, or others of the higher types of Mammalia. It develops three distinct heads, viz. an external head, an internal head, and a tibial head.

The *external head* arises rather far back upon the external aspect of the outer condyle of the femur, by a short, somewhat flattened, though a strong tendon. This origin is below the origin of the long end of the fibrous loops for the biceps, while the extremity of the short end of this loop is attached to the tendon of the external head of the gastrocnemius first, before it passes into its carneous portion. In form this muscular portion of the external division of the gastrocnemius is a broad flattened spindle; slightly concaved on its inner surface, and rather more convexed on its outer aspect. The lower apex of this portion of the muscle merges into

[1] "49. M. GASTROCNEMIUS.

M. primus posterior pedem et digitos movens. Aldrovandi.
M. septimus circa tibiam et fibulam. Steno.
Les muscles jumeaux. Vicq d'Azyr, p. 283, No. 1.
Grosser Wadenmuskel. Merrem, p. 460, No. 3.
Gastrocnemius. Wiedemann, p. 101.
,, Tiedemann, § 304.
,, Quennerstedt, p. 32.
,, Neander, p. 20.
,, De Man, p. 129, No. 17.
,, Gadow, No. 33.
,, Watson, p. 116.
Les gastrocnémiens. Cuvier, p. 539.
Wadenmuskel oder Fussstrecker. Meckel, *System*, p. 373, No. 3; *Archiv*, p. 273, No. 3.
Gastrocnemius internus + externus. Owen, *Apteryx*, pp. 294, 295.
Gastrocnémien et soléaire tibial. Gervais et Alix, pp. 34, 35.
Gastrocnémien (jumeau externe et interne + soléaire tibial). Alix, p. 451." (Gadow, *loc. cit.*, p. 183.)

the broad tendinous expansion, about opposite the junction of the lower and middle thirds of the tibial shaft.

The *internal head* arises from the outer surface of the inner condyle of the femur, and rather more posteriorly in point of situation than the corresponding origin of the external head. It is broad and more

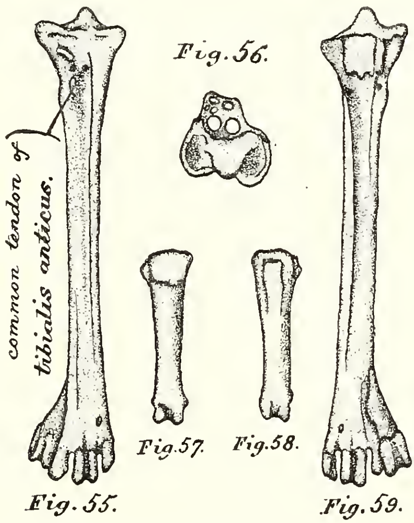

FIG. 55.—Anterior view of tarso-metatarsus of a Raven.
FIG. ~~56.~~—Posterior view of the same bone.
FIG. 57.—The summit of the same seen from above.
FIG. 58.—Basal joint of hallux, seen from above ; the joint taken from the same foot.
FIG. 59.—The same bone seen from beneath.

In the figures of the tarso-metatarsus the accessory or hallux metatarsal bone is *in situ*. Drawings designed to show the origin and insertion of muscles ; and all life-size, by the author, from his own dissections.

fleshy in character, while the distal end of the *adductor magnus* muscle makes a tendinous connection with the outer edge of this head, close to its origin, in a manner already described above. This internal, or what is really, more correctly speaking, the middle division of the gastrocnemius is the smallest by all odds. Its fibres pass directly down the middle of the back of the

leg, and merge into the broad tendinous expansion already alluded to in the last paragraph. The free edges of this portion are firmly attached by strong fasciæ to the mesial margins of the other two divisions. The tendon of the biceps passes between this head and the external one, while the fascia of the *accessory semitendinosus* is attached to its outer free edge above.

The *tibial head* of the gastrocnemius has a broad and fleshy origin from the entire inner rim bounding the tibial summit and from the free edge of the adjacent procnemial crest (Fig. 50).

This division of the muscle is somewhat larger than the external one, though of a very similar form. Its fibres below converge into a point which is situated rather lower down than the distal terminations of the carneous portions of either of the other divisions, and this point merges into the narrower portion of the common tendon of the muscle. This tendon, the superficial and median one of the lower fourth of the leg, develops in it, between the distal tibial condyles, a semilunar flattened piece of cartilage, which rides in a longitudinal groove over the true tibial cartilage, and is braced into position by a firm fascia, at the back part of the tarsal joint. Below this, the tendon of the gastrocnemius, hardly reduced in size, though gradually becoming thinner, passes down directly over the other tendons at the back of the tarsometatarsus, to merge into the fascia over them at about the middle of the bone. In all the lower part of its course it is held in its position by a strong fibro-tendinous fascia, fully capable of resisting the most powerful contractions of the muscle.

By way of comparison with what we have just given above for the Raven, we find this muscle wonder-

fully well developed in *Geococcyx*. All three of its heads are strongly defined, and the fleshy belly of the muscle is massive and thick.

Its *external head* arises, curiously enough, by two perfectly distinct tendinous slips. One of these, a strong, flat tendon, comes off from the outer surface of the external condyle of the femur, while the second slip, also strong but somewhat more rounded, arises from the back of the external femoral condyle, just above the trochlear surface. Between these two tendons of the external head of the *gastrocnemius* we find the loop for the *biceps* and the tendon of that muscle itself, the loop being quite intimately attached to the free edge of the outer tendon. Below the loop, these tendons merge with each other and terminate in the commencing fibres that compose the external head of the gastrocnemius proper.

The *internal head* of the gastrocnemius, or what is really the middle head in birds, is quite median in position, and is represented merely by a long, narrow, muscular slip that arises by a delicate, though strong, cord-like, tendon from the middle of the intercondyloid notch of the femur.

The *tibial head* of the muscle under consideration is massive in its dimensions when compared with the divisions of origin of the gastrocnemius already described. It arises fleshy from an extensive surface on the inner aspect of the head of the tibia as high up as the marginal boundary of its summit; and from the muscular fascia surrounding certain of the deep thigh-muscles, which are inserted into the distal end of the femur, and consequently are adjacent to the posterior aspect of the head of the tibia.

At a point about opposite the junction of the upper and middle third of the shaft of the tibia the internal

and tibial heads of the gastrocnemius merge with each other, while between their free edges above passes the exceedingly delicate tendon of the semimembranosus muscle.

All of the fibres of this complicated origin of the gastrocnemius muscle now converge and pass directly down the back of the leg of the bird. They also merge with each other in such a manner that, were we to examine the muscle at about the middle third of the leg, we should find it composed of two well-defined bellies, rather thin, nearly of equal size, united somewhat firmly by an intervening fascia, and each being convex on their superficial aspect and the reverse on their under sides, which concavity accurately moulds itself to the deeper layer of muscles of the leg, which the gastrocnemius completely covers.

At the lower fourth of the tibial shaft the fibres terminate in a broad, flat, and glistening tendon, which passes flat-wise over the shallow and longitudinal groove of the *tibial cartilage*, at which point the tendon is considerably thickened. Next, crossing the tibio-tarsal joint, it becomes internally attached to the hinder surface of the hypotarsus of the metatarsal bone, below which protuberance it finally merges into the deeper layer of the podothecal sheath confining the flexor tendons.

110. *The soleus*[1] is exposed when we remove the tibial division of the gastrocnemius. It is found

[1] Provisionally, at least, I still propose to regard this muscle as the *soleus*, being by no means yet satisfied that it can be considered the homologue of the *plantaris* of the Mammalia. Aside from everything else, however, attention is especially invited to the fact that in the vast majority of birds it arises from the *tibia*, and its tendon below merges with the *gastrocnemius*. In support of its being the homologue of the *plantaris*, Gadow has said :—

" Bei einigen Vögeln entspringt der Muskel weiter proximalwärts,

to be a somewhat flattened, small muscle, pointed below, but arising by carneous fibres from quite a broad base at the back of the head of the tibia. The broad, thin tendon of insertion of the semimembranosus overlaps its belly from the inner side. From its apex below it sends down a long, slender tendon, which is inserted into the proximal end of the "tibial cartilage," towards its inner angle. In the Apteryx, Owen found that the tendon of this muscle

nämlich von der Hinterfläche des *Condylus internus femoris*, doch kann dies durchaus nicht so häufig sein als Meckel angiebt, denn ich fond Ein femoralen Ursprung nur sehr selten, z. B. bei *Corythaix*, bestätigt. . . .

"Entspringt der *M. plantaris* vom Femur, obgleich vom inneren Condylus, so ist er beinahe vollständig dem gleichnamigen Muskel des Menschen homolog. Bei den Reptilien ist ein solcher Muskel in dem noch ungetheilten *Flex. long. dig.* enthalten."

I by no means consider this argument as being especially cogent in support of the muscle being considered the *plantaris*. Far more extended observations upon the myology of the Vertebrata generally are required to decide such a point as this. Gadow gives further the following synonymy (*loc. cit.*, pp. 185, 186):—

"50. M. PLANTARIS.

La grêle plantaire. Vicq d'Azyr, 283, No. 2.
Plantaire. Cuvier, 539.
Plantaris, vielleicht hinterer Schienbeinmuskel. Meckel, *System*, 375, No. 4.
Ohne Namen. Reid, pp. 144, 145.
Soleus. Owen, 295.
Jambier postérieur. Gervais et Alix, 35.
,, ,, Alix, 452.
Plantaris. De Man, 130, No. 18.
,, Gadow, No. 40.
,, Watson, 119."

Note.—I observe that Selenka, in his drawing of the muscles of the lower extremity of a Gull (*Larus fuscus*), marks this muscle as the *soleus* (see Bronn's *Klassen des Thier-Reichs*, vi. Band, Taf. xxiii).—R. W. S.

"joins that of the *gastrocnemius internus*, behind the tarsal joint" (*Anat. of Verts.*, vol. ii. p. 106).

The *soleus* (Fig. 65 *bis*) is a well-developed muscle in *Geococcyx californianus.* It arises from behind the

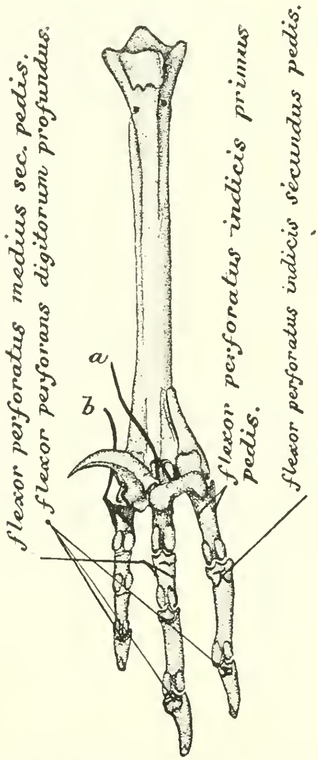

Fig. 60.—The skeleton of left foot of a Raven seen from behind; designed to show origin and insertion of muscles, and drawn life-size, by the author, from his own dissections. *a*, line of tendon of the *flexor perforatus medius primus pedis.* *b*, is the line of the tendon of the *flexor perforatus annularis primus pedis.* The exact insertion of these tendons are somewhat hidden by the hind claw and basal joint, and they are drawn to some extent diagrammatically.

tibia, on its inner side, and just below the marginal rim of its summit. The fibres at once form a little flat muscle, rather longer in shape than the fish from which

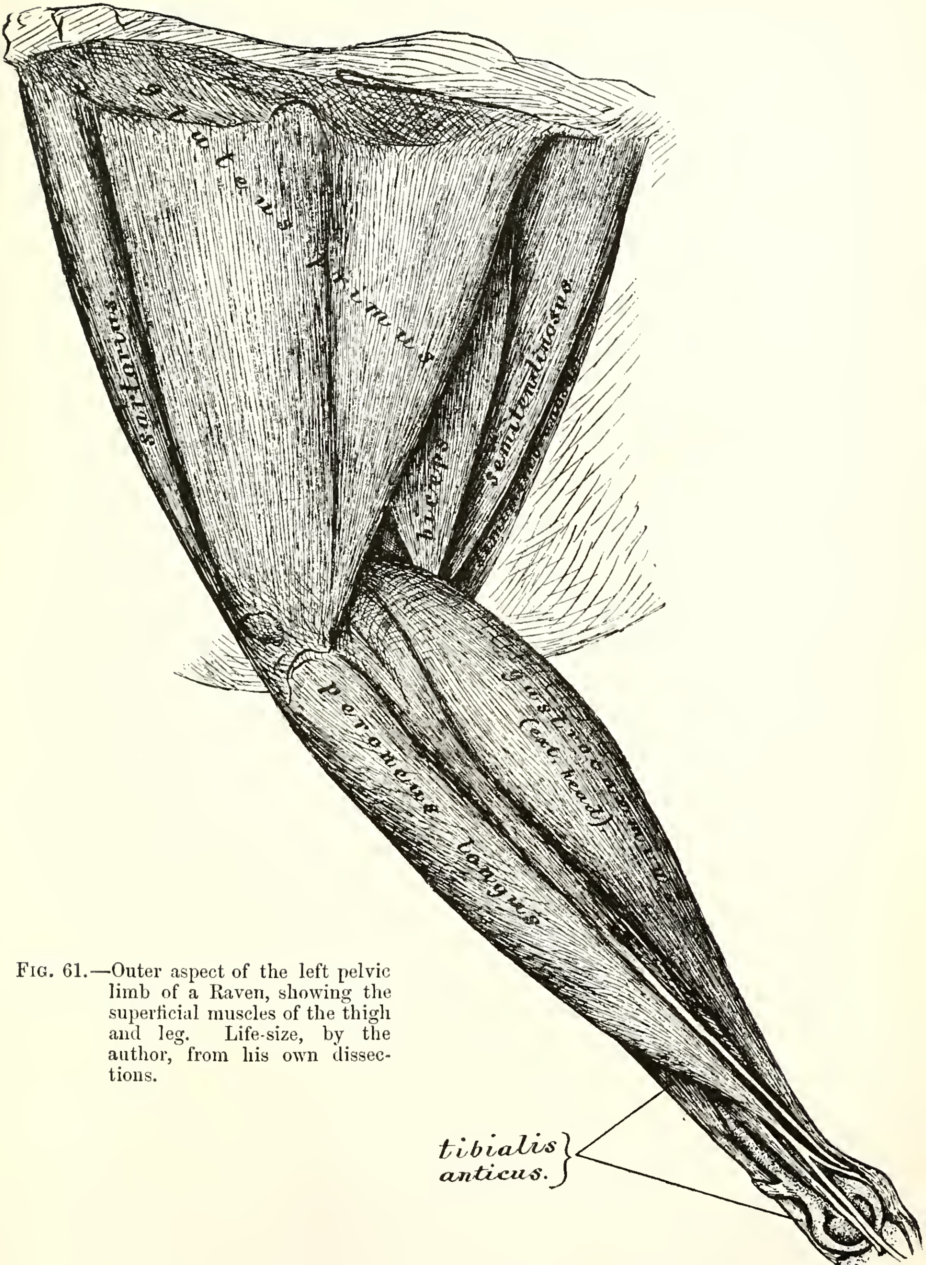

FIG. 61.—Outer aspect of the left pelvic limb of a Raven, showing the superficial muscles of the thigh and leg. Life-size, by the author, from his own dissections.

it derives its name, and soon terminate at the lower or tail-end in a tendon. This tendon, long and narrow, passes directly down the postero-internal aspect of the leg to become inserted into the dense fascia covering the tibial cartilage at its supero-internal angle.

Professor Mivart says that in Ornithorhynchus this muscle is inserted into the astragalus. And that further, in *Nycticebus* it has lost its tibial attachment, is entirely muscular, and blends with the gastrocnemius. This same author also informs us that in the Agouti it arises from the tibia only, while it is wanting in the Pig, Hyæna, Seal, and others (*Elem. Anat.*, p. 354). I present these comparative notices of such muscles as the *soleus* in others of the Vertebrata in order that we may have before us at least short histories of the muscle in question, which often prove suggestive.

Another word here in regard to the "tibial cartilage." I find a number of specimens, apparently very old birds, wherein its lower outer angle has ossified, and quite a sizable sesamoid is there formed, with a facet for the tibia.

111. *The peroneus longus*[1] is very well developed

[1] A very full description of this muscle is given by Professor Gadow, to whom we are also indebted for the subjoined nomenclatural record, to wit:—

"47. M. PERONEUS SUPERFICIALIS.

M. quartus posterior pedem movens. Aldrovandi.
M. decimus circa tibiam et fibulam. Steno.
L'accessoire des fléchisseurs des doigts du pied. Vicq d'Azyr, 1774, p. 510, No. 1.
Innerer Beinmuskel. Merrem, p. 160, No. 2.
Extensor tarsi externus. Wiedemann, p. 99.
M. tibialis posticus. Tiedemann, § 305 ; Carus, Erläuterungstafeln.
Langer oberer Wadenbeinmuskel. Meckel, *System*, p. 384 (innerer stärkerer Kopf von No. 2).

in our present subject, being a broad, muscular sheet, that covers or nearly conceals from view all the muscles on the anterior aspect of the leg, and principally the *tibialis anticus*.

It arises from the raised cnemial crest in front of the head of the tibia, and from the fascia that covers the outer side of the knee-joint. The fibres, forming a closely-fitting, muscular curtain embracing the front of the leg, pass downwards, then downwards and outwards to terminate in a small tendon at about the lower third of the tibia. This tendon bifurcates just above the tibial condyles at the outer aspect of the limb. The shorter and stronger fork of the bifurcation goes to the upper end of the *tibial cartilage*, to become attached to the fibrous fascia covering it; while the smaller slip passes to the outer side of the hypotarsus of the tarso-metatarsus, to meet the tendon of the *flexor perforatus medius primus pedis* obliquely, and merge with it at the back of that bone, about one centimetre below the hypotarsus.

Langsehniger Sohlenmuskel. Meckel, *Archiv*, p. 273, No. 4.
Moyen péronier. Arvier, p. 542.
Peroneus medius. Owen, *Comp. Anat.*, ii. p. 108.
Soleus et peroneus longus. Gurlt, p. 30.
Peroneus longus. Owen, *Cyclopædia*, p. 297; *Apteryx*, p. 296.
,, ,, Quennerstädt, p. 36.
,, ,, Neander, p. 21.
,, ,, De Man, p. 134, No. 24.
,, ,, Watson, p. 123.
Peroneus longus s. communicans. Nitzsch, in Giebel's *Zeitschrift*, x., 1857, p. 24 u. 240.
Long péronier. Gervais et Alix, p. 34; Alix, p. 450.
M. peroneus superficialis. Gadow, No. 29."

Note.—I question whether the *peroneus medius* of Owen (*Comp. Anat.*, ii. p. 108) is the present muscle as is quoted in the above synonymy; but am inclined to think that the *peroneus longus* of the same author, on p. 107 of the same work, may more properly be considered so.—R. W. S.

I designate as the *tibial cartilage* that fibro-cartilaginous block lying between the tibial condyles behind, over which the tendon of the gastrocnemius passes, and through which the tendons of the flexors of the podal digits glide. Thus we see that the *peroneus*

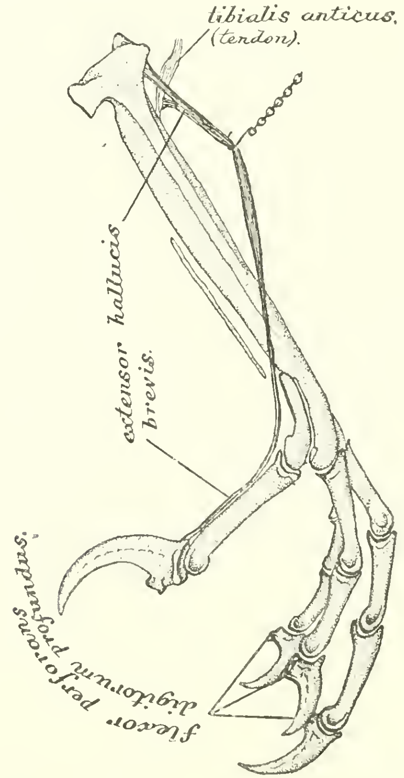

FIG. 62.—The skeleton of the left foot of a Raven, seen from the side ; designed to show passage and insertion of tendons, &c. Drawn life-size, by the author, from his own dissections.

longus in the Raven takes the part of an auxiliary to the flexors of the toes, assisting them in their action.

According to Sir Richard Owen, the present muscle in the Apteryx behaves in a very similar manner in the lower part of the leg to what I have just described

for the Raven. We find in the Apteryx that the "*peroneus longus* arises tendinous from the head of the tibia, and by carneous fibres from the upper half of the anterior margin of the tibia; these fibres pass obliquely to a marginal tendon, which becomes stronger and of a rounded form where it leaves the muscle. The tendon gives off a broad, thin, aponeurotic sheath, to be inserted into the capsule of the tarsal joint; it is then continued through a synovial pulley on the side of the outer malleolus, and is finally inserted or continued into the perforated tendon of the middle toe" (*Anat. of Verts.*, vol. ii. pp. 107, 108).

In reflecting the *peroneus longus* in the Raven, and viewing its under side, we observe that where it takes origin from the free points of the pro- and ectocnemial processes it is very tendinous, and these tendons can be distinctly traced down on this surface of the muscle for some little distance, forming lateral boundaries to the more carneous central portion.

112. *The tibialis anticus*[1] is a very interesting muscle

[1] This muscle has been very generally considered to be the *tibialis anticus* by morphologists, as will at once be appreciated by the synonymy given us by Gadow, viz :—

"45. M. TIBIALIS ANTICUS.

M. secundus anterior pedem movens. Aldrovandi.
M. undecimus circa tibiam et fibulam. Steno.
Le tibial antérieur. Vicq d'Azyr, 1774, p. 510, No. 2.
Anzieher des Fusses. Merrem, p. 164, No. 4.
Tibialis anticus. Wiedemann, p. 99.
" " Tiedemann, § 306.
" " Owen.
" " Neander, p. 22.
" " Quennerstedt, p. 38.
" " De Man, p. 135, No. 26.
" " Gadow, No. 31.
" " Watson, p. 48.
Le tibial ou jambier antérieur. Cuvier, p. 539; Alix, p. 448.

in the bird we now have under consideration. Its carneous portion is divided into two very distinct parts, which, though moulded together, are easily separable clear down to that point where they unite with their common tendon below. The inner head—if we may be permitted to so term these divisions—arises immediately beneath the *peroneus longus* from a semilunar area high up between the pro- and ectocnemial crests on the anterior aspect of the head of the tibia. This division forms the anterior half of the muscle, its origin being quite extensive, and principally fleshy. The "outer head" of the muscle arises by a short, strong tendon from the base of a little pit found upon the antero-inferior ridge of the outer condyle of the femur. This head is overlapped by the fascia of the knee-joint and the great flexor at the back of the leg, but, passing beneath these, it immediately moulds itself upon the anterior half, though there is no blending of fibres whatever, it being situate completely behind it. The two then pass directly down the front of the leg as a large and handsome fusiform muscle. At the lower third of the bone their fibres converge to a point, to become attached to a strong and powerful tendon common to the two divisions; this, passing through the oblique, fibro-cartilaginous bridge just above the tibial condyles, goes directly, in the antero-median line, to a point on the shaft of the tarso-metatarsus just below the head of that bone, where it is finally inserted upon a tubercle, there found, and which is intended for it.

Both the *peroneus longus* and the *tibialis anticus* are well developed in such a bird as *Geococcyx californianus*, and have essentially the same origins and insertions as

Vorderer Schienbeinmuskel. Meckel, *System*, 370, No. 1; *Archiv*, p. 272, No. 1.

Levator pedis. d'Alton, p. 36."

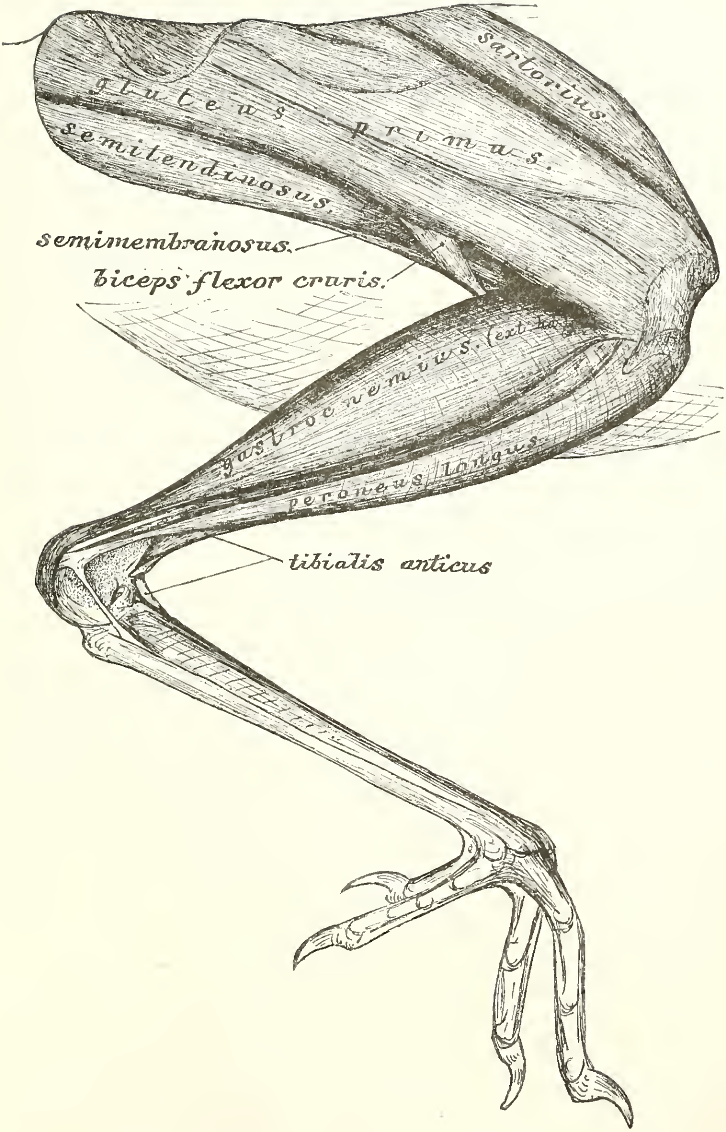

FIG. 62 *bis*.—Outer aspect of the right pelvic limb of the "Road Runner" (*Geococcyx californianus*), showing the superficial layer of muscles, and the relations of the *peroneus longus* and the *tibialis anticus* are especially to be observed. Life-size, by the author, from his own dissections.

we have described for them above, as they exist in the Raven. We have good views of them in Fig. 62 *bis* of the present work. Several years ago I devoted no little attention to the myology of *Geococcyx*, and published my observations thereon in a number of places. The bird, as is well known, occurs on the Pacific coast region of the United States, and presents much of interest in its anatomy. It is a big Ground Cuckoo with affinities in other directions.

To become impressed with the great number of changes to which this muscle is subject, we can do no better than to read Professor Mivart's account of it, as we find it among other representatives of the Vertebrata.

This eminent anatomist tells us that "the *tibialis anticus*, even in Anthropoid Apes, may have the part going to the hallux so distinct as to be reckoned a distinct muscle—sometimes called the *abductor longus hallucis.* It may be unquestionably double, as in the Echidna. It may have a double origin and single insertion, as in the Agouti. It may be inserted into the second metatarsal, as in Hyrax; and may be altogether wanting, as in the Pig. It is inserted into the tarso-metatarsal bone in birds, and is situate quite on the inner aspect of the leg in *Chameleo.* It exists down to the Urodeles, being apparently double even in *Menobranchus.* It may arise from the femur, as in the Frog" (*Elem. Anat.*, p. 351).

Owen also found the *tibialis anticus* overlapped by the *peroneus*, and arising partly in common with that muscle, "and partly by separate short tendinous threads from the outer part of the head of the tibia; it gradually becomes narrower, and finally tendinous two-thirds of the way down the leg; its strong tendon glides through the oblique pulley in front of the distal end of the tibia, expands as it passes over the ankle-

joint, and is inserted into the anterior part of the proximal end of the tarso-metatarsal bone, sending off a small tendinous slip to the aponeurosis covering the extensor tendons of the toes, and a strong tendon which joins the fibular side of the tendon of the *extensor longus digitorum*" (*Anat. of Verts.*, vol. ii. p. 108).

In man, we remember, the *tibialis anticus* is a direct flexor of the tarsus upon the leg.

113. *The extensor longus digitorum*[1] (Fig. 51) arises fleshy from the under edge of the procnemial ridge or crest of the tibia, its mesial side, and from a limited area of the contiguous surface of the shaft of the bone. Its fibres pass down on the interno-anterior aspect of the tibial shaft, as a long, slender, fusiform muscle. At the lower third of the bone its strong tendon supplants the carneous portion, and gradually coming to the middle line, passes under the bony bridge just above the condyles in front. Emerging from this, it passes over the front of the ankle-joint, being bound down in this situation by a firm fascia. It is now slightly

[1] A study of the methods of insertion of this muscle throughout the Class *Aves* is a very interesting one, and shows it to be very different in several of the groups. Gadow gives its synonymy as follows :—

"46. M. EXTENSOR DIGITORUM COMMUNIS.

M. primus anterior pedem et digitos movens. Aldrovandi.
M. duodecimus circa tibiam et fibulam. Steno.
L'extenseur commun des doigts. Vicq d'Azyr, p. 282, No. 3.
Schienbeinmuskel. Merrem, p. 161, No. 5.
M. extensor digitorum communis. Wiedemann, p. 100.
" " " " Tiedemann, § 308.
" " " " Quennerstedt, p. 39.
" " " " Neander, p. 23 ; Gadow, No. 32.
" " " " Watson, p. 126.
Extensor digitorum longus. Owen, *Apteryx*, p. 297.
" " " De Man, p. 135, No. 27.
L'extenseur commun des doigts. Gervais et Alix, p. 33 ; Alix, p. 453."

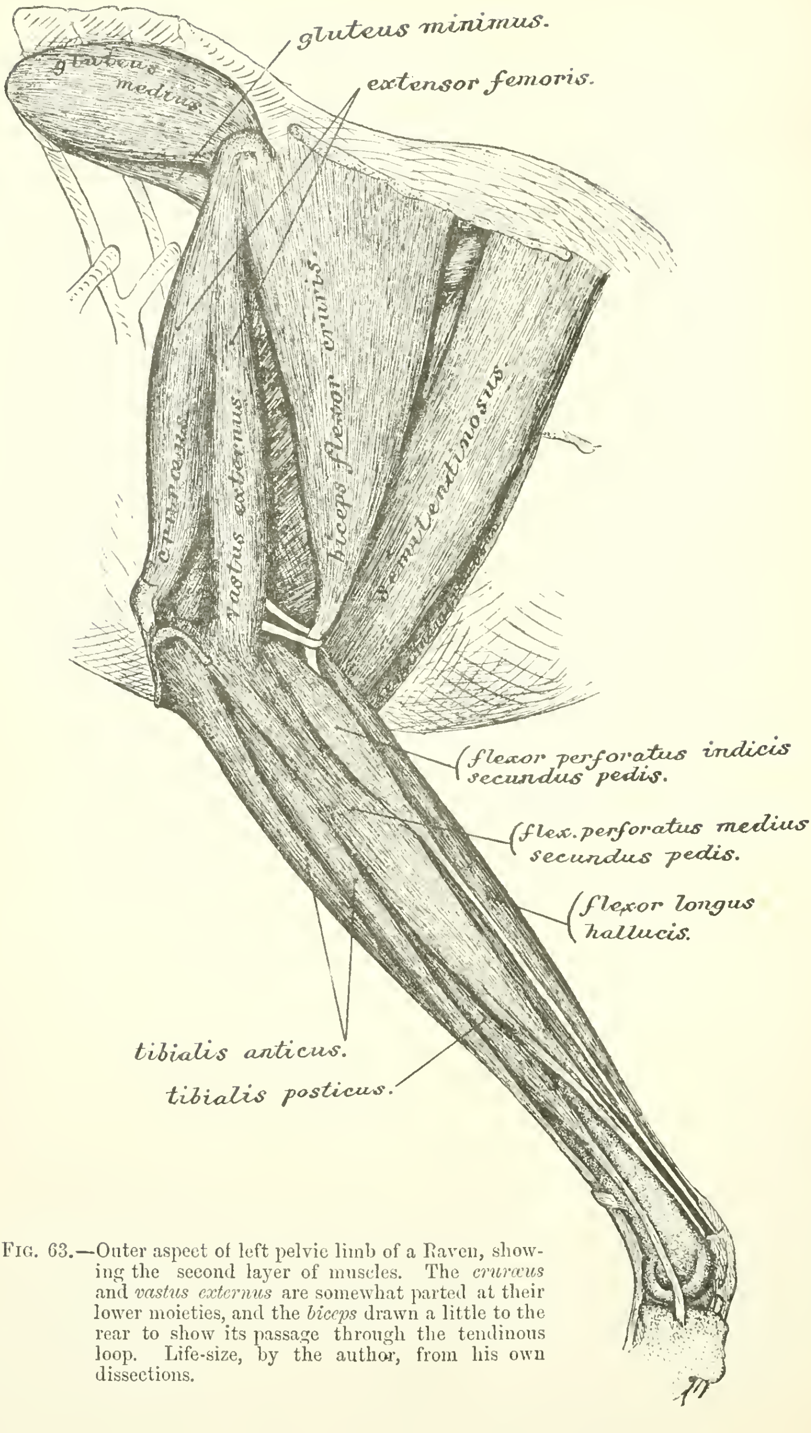

FIG. 63.—Outer aspect of left pelvic limb of a Raven, showing the second layer of muscles. The *cruræus* and *vastus externus* are somewhat parted at their lower moieties, and the *biceps* drawn a little to the rear to show its passage through the tendinous loop. Life-size, by the author, from his own dissections.

deflected to the inner side, and just above the tubercle on the tarso-metatarsus for the insertion of the tendon of the *tibialis anticus*, it passes through a special little bony arch there found for it. It then passes down the interno-anterior edge of this bone to the trochleæ of the basal toe-joints. Here it divides into three smaller tendinous slips; these pass respectively over the superior aspects of the second, third, and fourth toes, bifurcating as they do so, beyond the basal joints, to be inserted at the bases of the distal ones. At the proximal extremity of each series of phalanges, the tendons are bound down in the median grooves intended for their passage and guidance by a strong, fibrinous, fascia-like sheath.

This muscle receives on its outer side a separate slip that might almost be reckoned as a minor head were it not in such a rudimentary state.

It arises as a small bundle of carneous fibres from a limited elliptical area on the front of the shaft of the tibia, near its middle, and about opposite the proximal end of the fibular ridge. It passes down to the outer side of the *extensor longus digitorum* proper, and in close contact with it, and about two centimetres down, it develops a feeble, fascia-like tendon, which with the terminal fibres of the muscle itself soon merge with those of the large extensor at its side. The *tibialis anticus* must be removed before this delicate little slip can be brought into view, as it lies immediately beneath it (Fig. 51).

Upon another occasion, when speaking of this muscle as it is found in *Geococcyx*, I said :—

"The *extensor longus digitorum* (Fig. 64 *bis*) arises from the anterior aspect of the inner half of the tibial shaft as high up as the *tibialis anticus* muscle, which covers it; it also arises from a tense fascia which comes off from the lower free edge of the procnemial crest of the tibia;

and finally from a longitudinal line extending obliquely down the front of the shaft of the tibia to its lower third. This obliquity finally brings the tendon in which the *extensor longus digitorum* terminates to the middle line.

"Just above the condyles of the tibia, it here passes through the little bony bridge; emerging from which it crosses the ankle-joint in front, then passes down the anterior aspect of the tarso-metatarsus bone, overlying the short extensor. At the upper end of this last-named bone, and over the ankle-joint, this tendon is firmly bound down by a fibrous fascia. In some birds we know a special bony span exists for it on the upper part of the tarso-metatarsus, as in certain Owls. When the tendon of this muscle arrives at the anterior aspect of the trochleæ of the distal end of the tarso-metatarsus, it expands and bifurcates. The tendinous expansion becomes more or less attached to the underlying tissues, while each bifurcation passes one over the second, and the other over the third toe, for their entire lengths, to become inserted into the upper points of their ungual phalanges.

"Now from the side of the tendon that goes to the third toe another slip is differentiated off in a very peculiar manner, owing to the reversion of the toe in question. For it not only passes over the top length for insertion of this fourth digit, as in the case of the others, but its slip also splits off to make a separate insertion at the extremity of the basal phalanx of the third digit. I have had the opportunity of dissecting three feet, with the view of studying this point, and I find it to obtain in all of them."

114. *The extensor hallucis brevis*[1] is an exceedingly

[1] As I read the above account I have given of the *extensor hallucis brevis*, I am convinced that I was compelled to so name it myself for our Raven; and the literature of the subject was at that time not available to me, and I was not aware that it had

interesting little muscle. It arises fleshy from the antero-internal aspect of the head of the tarso-metatarsus, just below its summit; from the corresponding edge of the shaft below; and from the tendon of the *tibialis anticus.* The delicate little bundle of fibres pass down the antero-internal edge of the shaft of the bone, which is slightly concaved to receive them, in order that the close-fitting podotheca may not interfere with their proper action; when just before arriving at the apex of the accessory metatarsal, they unite with a delicate, though strong, little tendon, which, passing round behind that bone and over the hallucial basal joint, runs along over the top of the phalanx of the hallux close to the bone, to be finally inserted into the process at the superior base of its bony claw.

Professor Owen, in the second volume of his *Anatomy of Vertebrates,* describes also an *extensor brevis digitorum*; but that muscle does not occur in the Raven, and the

received a similar designation at the hands of others. Gadow has bestowed the same name upon it, and furnished the following synonymy :—

"54. M. EXTENSOR HALLUCIS BREVIS.

M. primus anterior tarsi. Aldrovandi.
M. primus circa os quod supplet vices ossium tarsi et metatarsi. Steno.
L'abducteur du doigt opposé. Vicq d'Azyr (1805), p. 288.
Extensor hallucis. Wiedemann, p. 106.
,, ,, Tiedemann, § 315.
,, ,, d'Alton, p. 39; Owen, p. 297.
,, ,, Quennerstedt, p. 48.
,, ,, Neander, p. 28.
,, ,, Gadow, No. 41.
L'extenseur propre du pouce. Cuvier, p. 553.
Extensor of the thumb. Reid, p. 145.
,, *digitorum brevis* (pt.). Gurlt, p. 32.
,, *brevis hallucis.* De Man, p. 138; Watson, p. 126.
,, *unguis.* Garrod, *P.Z.S.*, 1872, p. 363.
L'extenseur du pouce. Alix, p. 447."

one I have last described seems to correspond to this writer's *extensor pollicis brevis*, but his description is not very definite.

I dissected four pairs of feet of this species,—and the dissection is by no means an easy one,—before I was satisfied that the facts in regard to these short extensors of the toes are as I have given them above. They were the same in all, and in all the *extensor brevis digitorum* of Owen was absent.

Professor Mivart, in his *Elementary Anatomy*, does not mention the short extensor of the hallux as occurring in birds, and this eminent biologist calls this muscle the *extensor proprius hallucis.*

In certain birds with zygodactyle feet, as in *Geococcyx* for instance, the morphology of the *extensor hallucis brevis* is quite different, and when treating the myology of *G. californianus* it led me to consider the present muscle as only a part of the *extensor brevis digitorum* in that form, and I said in effect that the *extensor brevis digitorum* is a muscle that may be taken as an amplification of the muscle I have described in the Raven as the *extensor hallucis brevis.*

But even here in *Geococcyx* the short extensor of the hallux has a certain amount of individualization, though it is not fully differentiated from the other part of this *extensor brevis* (Fig. 64 *bis*). It, however, is not attached more than half-way down the anterior aspect of the shaft of the tarso-metatarsus, at which point it terminates in a delicate thread-like tendon ; this passes directly over the upper border of the accessory metatarsal, and along the top of the basal joint of the hallux, to become inserted in the usual manner in the base of the claw-joint. Now the remainder of the *extensor brevis digitorum* is attached down the shaft of the tarso-metatarsus, as far as the distal trochleæ ; the outer

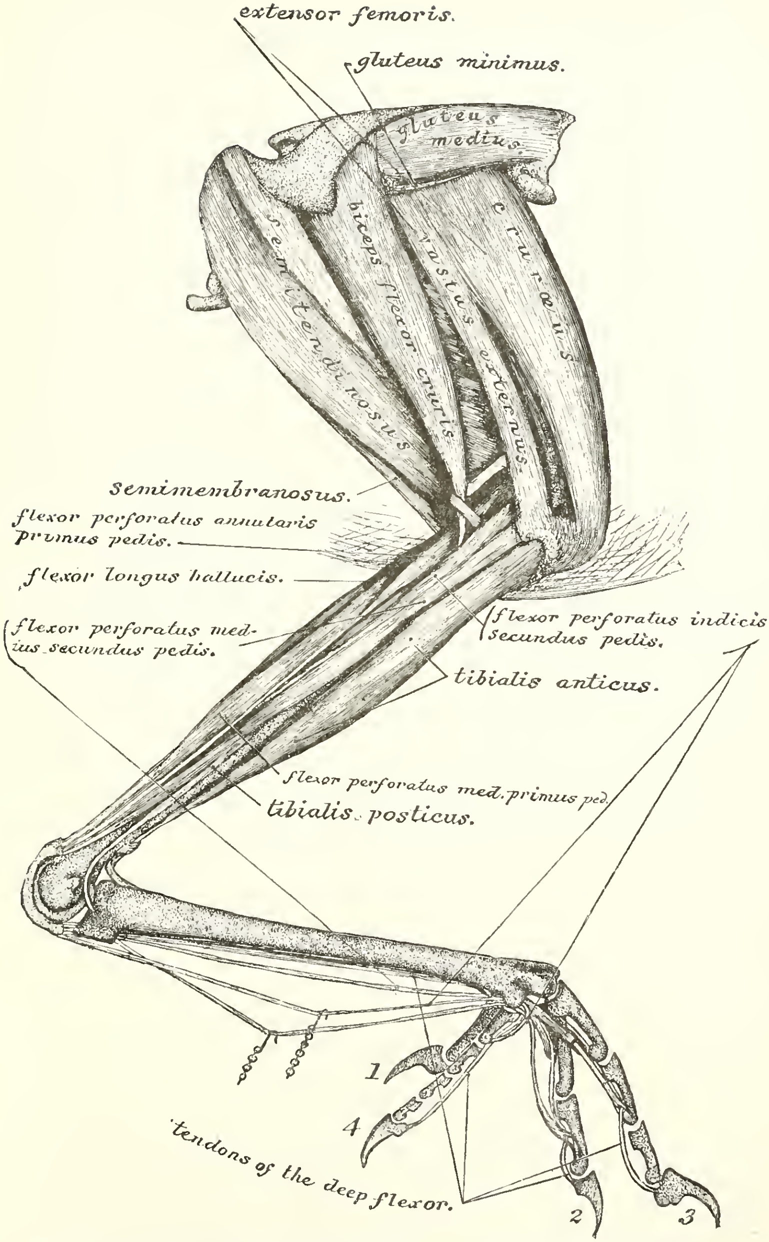

FIG. 63 *bis.*—Pelvic limb, right side, of *Geococcyx californianus*, same specimen as is shown in Fig. 62 *bis*. The superficial layer of muscles have here been removed, and those found beneath them brought more fully into view. Life-size, by the author, from his own dissections.

portion of it developing a tendon about half-way down, which is concealed by the carneous fibres which overlie it. This tendon passes round beneath the trochlea for the fourth toe, and is really inserted on the *under side of the basal joint* of this digit at its proximal extremity; so that in the case of this toe it seems as though it would act almost as a *flexor*. With the second and third toes, however, the carneous fibres of the muscle under consideration are continued all the way to the trochleæ, where they terminate, in either case, in a strong, flat tendon, which passing over the joint is inserted *on the upper side* of the proximal extremity of the basal joint. Here, of course, the muscle acts (in the case of the second and third toes) as an auxiliary to the long extensor.

Not a little room is here open to us for speculation as to how the tendon of this short extensor in the case of this fourth toe exactly came to assume its present point for insertion, as the digit gradually and finally became permanently reversed. Indeed, the high development of this short extensor in *Geococcyx* over the vast majority of the class is, too, an interesting fact; and did the reversion of the digit precede or follow the muscular development? No doubt the completeness of the latter, and its perfection for an avian type, has come about as a demand on the part of the habits of the bird itself and its marvellous fleetness of foot.

The muscles of the leg thus far dissected out should now be carefully examined, particularly in regard to their relations, and the relations and passage of their tendons. They should next be removed close up to their origins and insertions, and all superfluous tissue removed,—as fat, the vessels and nerves, and fascia and connective tissue—leaving the muscles at the back of the limb perfectly clean, and in as favourable condition to study as possible. Next the podotheca of the tarso-metatarsus and

toes should be removed with the greatest care, using a sharp scalpel for the purpose. This will take fully an hour, as we should be particularly guarded not to injure in the slightest degree any of the tendons, or disturb their mutual relation to each other. At the end of our work nothing should be left but the skeleton of the limb; the muscles and their tendons *in situ;* and the *tibial* cartilage so trimmed as to show precisely the manner in which the tendons pass through it, and their relations to each other.

It is a good plan now to fasten the limb down to a smooth surface in such a manner that the posterior aspect faces upwards and towards you, then by means of little hooks and dissecting chains the individual muscles and their tendons can be raised in such a manner as to greatly facilitate their study. I am thus particular in these details because I have experienced no little difficulty myself in properly comprehending these parts, and it is simply out of the question to do it at all by a hasty dissection.

Now it will be seen, as a sort of a first introduction to these parts, that the hind toe or first toe is under the control of two tendons (whatever their muscles may be above): the first of these is the delicate little *extensor hallucis brevis* (Fig. 60) already described, and the second a powerful flexor tendon running along underneath its basal joint. This tendon at the back of the tarso-metatarsus ossifies, and the bone is usually something longer than two centimetres. Others of the larger tendons in the same situation do the same thing in old specimens. These bones are shown at the back of the tarso-metatarsus in Figs. 49 and 60.

Confining ourselves now to the sole of the foot in this cursory examination, we see that the second toe (with two joints and a claw) is served by three tendons coming

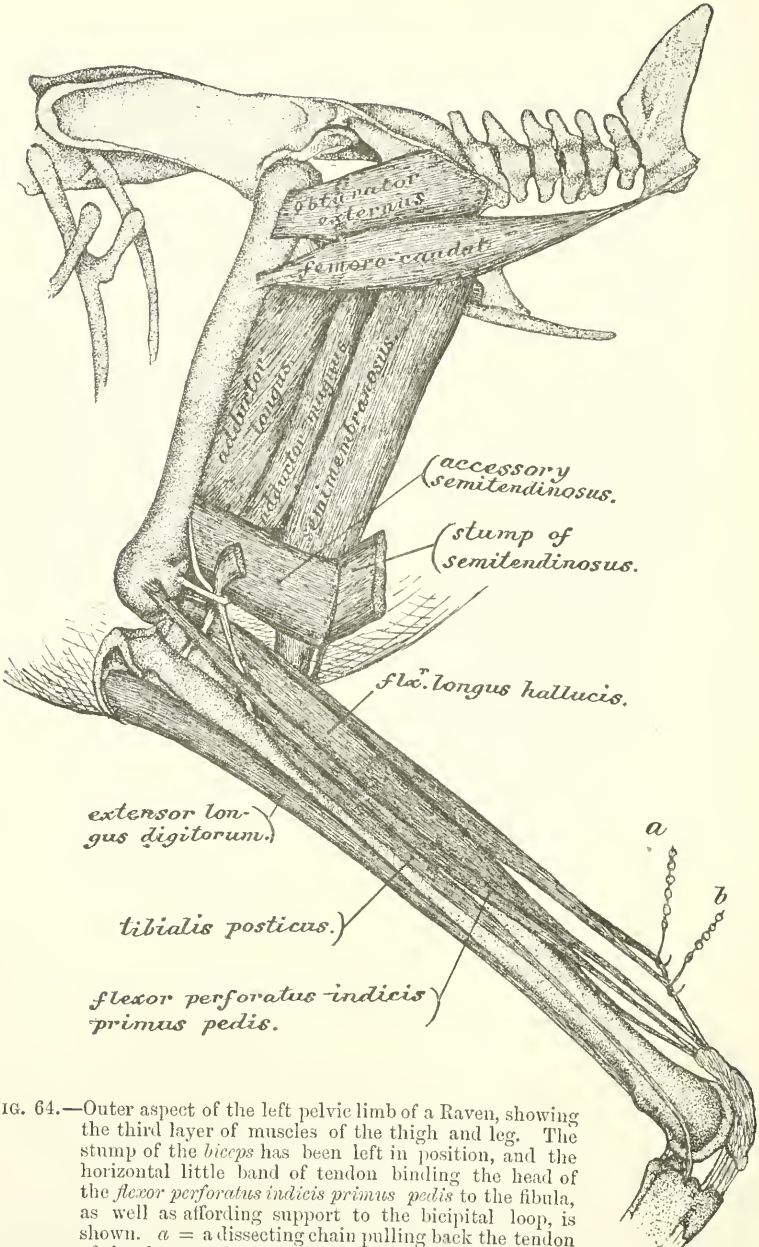

FIG. 64.—Outer aspect of the left pelvic limb of a Raven, showing the third layer of muscles of the thigh and leg. The stump of the *biceps* has been left in position, and the horizontal little band of tendon binding the head of the *flexor perforatus indicis primus pedis* to the fibula, as well as affording support to the bicipital loop, is shown. a = a dissecting chain pulling back the tendon of the *flexor perforatus annularis primus pedis* muscle; and b, accomplishing the same for the tendon of the *flexor perforatus medius primus pedis* muscle. Life-size, by the author, from his own dissections.

from muscles at the back of the leg. One of these perforates the other two, and runs the entire length of the toe, to become inserted at the tubercle at the under side of the bony core of the claw or the ungual phalanx. Of the two perforated tendons the longer one is inserted at the distal end of the basal phalanx, and the shorter one at the middle of the shaft of the same bone. In the middle or third toe (with three joints and a bony claw) we find also a long *perforating* tendon inserted as in the last toe, with the longer *perforated* tendon inserted at the distal extremity of the second phalanx, while the shorter one stops at a point over the shaft of the basal joint. Now the outer toe (with four joints and an ungual phalanx or bony claw) has but *two* tendons, one perforating and the other perforated. The perforating one behaves as in the other toes, running clear to the tubercle at the lower base of the ungual phalanx for insertion, while the perforated one sends down its bifurcations, one on either side of the perforating tendon, to be inserted in the one case over the shaft of the basal joint, and in the other at the distal end of the joint next beyond, thus making up for the absent tendon in this toe.

It is evident from this we have in the *second* and *third* toes a *perforating* tendon and two *perforated* tendons, while in the *fourth* toe we have a perforating and a perforated one. *All of these tendons at the back of the tarso-metatarsus bone are separate.*

I have carefully read over and compared the writings upon the plantar or flexor tendons in birds, by Owen, Garrod, Forbes, Mivart, and Coues, and am convinced that no little difference of opinion obtains among these writers, and I regret to say that I am compelled to introduce still another opinion in the case of two or three of

the muscles in question, but only after the most conscientious study. Nor do I expect my opinion will hold for all forms of birds, for as I have so often stated on previous occasions, an enormous amount of work still remains to clear up even these simple questions in biology.

Garrod and Forbes had chiefly to do with a limited number of the plantar tendons, and I believe, so far as they go, describe them correctly. Mivart has but little to say about the musculature of these parts in Aves, and I fail to find that any of these authorities speak of the *two sets* of perforated tendons, with the exception of Owen, who after describing a *flexor perforans digitorum*: a *flexor perforatus* of the outer toe; a *flexor perforatus digitorum*; and as I say, a *peroneus longus* and *medius*, says without any further explanation that "The second and third toes have two perforated tendons; one inserted into the sides of the first, and the other into the sides of the second phalanx" (*Anat. of Verts.*, vol. ii. p. 109), but says nothing of the muscles from whence the second set are derived.

In view of the fact that a bird's *hand* and arm have become completely subordinated to the purposes of flight, and that its *foot* has become converted largely into an instrument of prehension, is it not possible —nay, quite probable—that a higher specialization of the muscles has, *pari passu*, become a necessity? and that the *peronei* muscles (beyond the *peroneus longus* with its strikingly feeble insertion) are not represented in these peculiarly modified vertebrates, so far as their extremities are concerned? These *peronei* muscles are by no means constant, and are chiefly confined to the class Mammals.

Such facts must have their weight in our myological

nomenclature, and oftentimes, in the present state of our knowledge of such matters, a certainty of diagnosis in homology is simply out of the question.

In distinguishing the flexors I will bestow such names upon them as will show their methods of insertion; for instance, the *perforated* tendons inserted into the *basal* phalanges will bear the name of *primus*, with the name of the particular toe. In this last designation we will call the second toe *indicis*, as it corresponds to the index of manus; and if occasion calls for it, we will designate the next toe as *medius*, and the outside one as *annularis.* It is unnecessary to say that the term *perforans* refers to a tendon that *perforates;* and *perforatus* to one that *is perforated.*

Now the perforated tendons of the second row of phalanges had better be designated by the word *secundus*, should they be sufficiently individualized as to warrant their being described as belonging to separate muscles.

It probably will not be necessary to use all these names, and I simply throw them out as a suggestion, though, as I say, if occasion requires it, the nomenclature adopted will be upon this plan, and in the present subject some of them will be brought into use.

115. *The tibialis posticus* arises from the whole length of the shaft of the fibula below the insertion of the *biceps flexor cruris;* from the shaft of the tibia for a little distance below it; from the interosseous membrane; and the adjacent surface of the tibial shaft. It is in intimate relation with the *flexor perforans digitorum pedis*, which overlies its mesial portion, and the two muscles in this situation blending by their fibres. The *tibialis posticus* is a long, subcylindrical muscle, and passing directly down the leg, from the origin just described, terminates in a strong tendon

at about the middle of the lower third of the shaft of the tibia. It passes in front of the external malleolus, crosses the ankle joint, and is finally inserted into the outer edge of the summit of the tarso-metatarsal bone.

This appears to be one of the *peronei* muscles of A. Milne-Edwards; but from the facts that it is evidently inserted into the tarsus, and not the metatarsus; and that the *tibialis posticus* is quite a constant muscle among Reptiles; and that further, as I have already said, the *peronei* muscles are more particularly mammalian institutions, I believe we are safer in calling this one the name we have.[1]

[1] The only muscle I can find in literature to compare the present one with is the *Peroneus profundus* of Gadow, who offers the following upon it (*loc. cit.*, p. 182):—

"48. M. PERONEUS PROFUNDUS.

M. tertius anterior pedem movens. Aldrovandi.
M. tridecimus circa tibiam et fibulam. Steno.
Le péronier. Vicq d'Azyr, p. 282, No. 4.
Wadenbeinmuskel. Meckel, *System*, p. 372, No. 2; *Archiv*, p. 273, No. 2.
Peroneus. Wiedemann, p. 101.
" Tiedemann, § 307.
" d'Alton, p. 36.
Le court péronier. Cuvier, p. 542.
" " Gervais et Alix, p. 34.
Peroneus tertius. Gurlt, p. 30.
" *brevis.* Quennerstedt, p. 37.
" " Neander, p. 22.
" " De Man, p. 135, No. 25.
" " Watson, p. 118.
Péronier latéral. Alix, p. 450.
Peroneus profundus. Gadow, No. 30.

"Der tiefe Wadenbeinmuskel erscheint nach Abtragung des *Peron. superficialis.* Er ist ein gewöhnlich kleiner, gegliederter Muskel, der fleischig von der vorderen und äusseren Fläche der Perone und von benachbarten Theilen der Tibia, in der Regel vom

In our *Geococcyx californianus* the *tibialis posticus* is a very slender muscle, but closely resembles the same muscle as I have found it in all other birds which I have examined for their myology.

As in a number of the Passeres, we find it here to arise from the antero-lateral aspect of the shaft of the fibula below the tubercle for the insertion of the *biceps flexor cruris*, from the interosseous membrane between the leg-bones, from the contiguous surface of the shaft of the tibia, and, finally, from the fascia separating it from the deep flexors of the leg. The fibres pass directly down the outer side of the tibia as a long, slender, fusiform muscle. At the lower fourth of the shaft of this bone they terminate in a small tendon, which, passing in front of the external malleolus, crosses the ankle-joint to become inserted into the supero-external rim of the summit of the tarso-metatarsus.

116. *The flexor perforatus indicis secundis pedis*[1] is

vorletzten Viertel des Unterschenkels entspringt. Die Ausdehnung des Ursprunges variirt jedoch ungemein.

"*Insertion.* Der Muskel geht in eine starke, rundliche Sehne über, welche am äusseren Malleolus durch ein *Retinaculum peronei* tritt und sich dann an der proximalen Ecke des mittleren oder hintersten der drei Tarso-Metatarsalknochen inserirt."

Note.—These remarks are here added on June 25, 1889, and in concluding I would say that the muscle certainly has an extensive fibular attachment in *Corvus*, and although it may eventually prove to be a *peroneus* muscle, I was in no ways influenced in naming it by any semblance it might have to that muscle so called in *Homo*, but rather by the fact that a *tibialis posticus* occurs in certain reptilian forms.—R. W. S.

[1] This muscle has the following account of its synonymy given by Professor Gadow:—

"52*a*. M. FLEXOR PERFORANS ET PERFORATUS DIGITI II.

M. tertius posterior circum tibiam et fibulam. Steno.

in the Raven a perfectly distinct muscle, and fully merits a separate description. It arises, somewhat tendinous, from the outer surface of the external condyle of the femur, just below the external head of the *gastrocnemius*. The fibres go to form a thin, flattened muscle, broadly spindle-shaped, and about three centimetres long, with its tendon merging with the spreading fascia of its outer aspect. This tendon is rather wide for the most part above, and very thin. It commences at the lower apex of the muscle, and takes a straight course to the supero-internal angle of the *tibial cartilage*, thus really passing in an oblique line across the back of the leg. It becomes gradually smaller as it nears this cartilage, which it passes through, superficially, to its outer side; then crossing to the tibio-tarsal joint, passes through a special canal in the hypotarsus, in the median row to the inner side. Its course is now directly down the back of the tarso-metatarsus, under the annular ligament of the sole of the foot, and a cartilaginous block beneath it to hold

Le fléchisseur perforé (pt.). Vicq d'Azyr, p. 283, No. 3.
Le muscle perforant et perforé (pt.) Cuvier, p. 558.
Zusammenzieher der Zehen (pt.) Merrem, p. 161, No. 7.
Flexor perforatus digiti interni. Wiedemann, p. 102.
,, ,, ,, ,, Tiedemann, § 309.
Zweiter hinterer Kopf des durchbohrten und durchbohrenden Zehenbeugers. Meckel, *Archiv*, p. 276, No. 9.
Erster hinterer Kopf des durchbohrten und durchbohrenden Zehenbeugers. Meckel, *System*, p. 380, No. 1.
Flexor digitorum sublimis s. perforatus (pt.). Gurlt, p. 31.
Flexor perforatus s. longus dig. (pt.). Owen, *Apteryx*, p. 295.
Fléchisseur perforé, couche superficielle (pt.). Gervais et Alix, p. 37.
Flexor digiti II. et III. (*perforans et perforatus*) (pt.). Quennerstedt, p. 40; Neander, 24.
Flexor perforatus digitorum (äusserer Kopf). De Man, p. 131, No. 20.
Flexor perforans et perforatus digiti II. Gadow, No. 34.
Flexor perforatus et perforans digiti interni. Watson, p. 122."

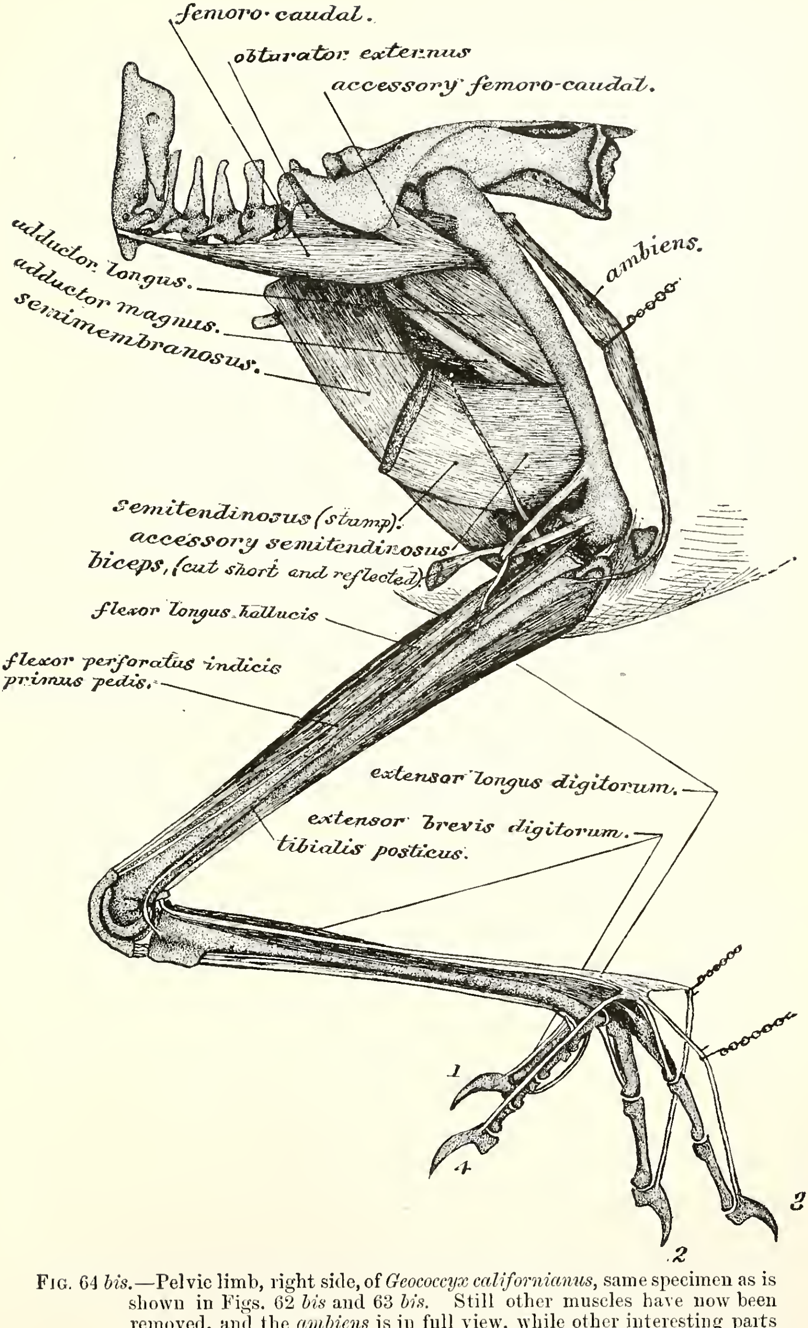

FIG. 64 *bis*.—Pelvic limb, right side, of *Geococcyx californianus*, same specimen as is shown in Figs. 62 *bis* and 63 *bis*. Still other muscles have now been removed, and the *ambiens* is in full view, while other interesting parts are brought into sight. Life-size, by the author, from his own dissections.

these tendons in place, over the trochlea, to the middle of the shaft of the second phalanx of the second toe. Here it makes fast to the sides of this bone as well as forming a tubular sheath for the passage of the deep flexor.

When this muscle alone contracts, by pulling on the second phalanx of the second toe it tends to flex it; when all the flexors of the limb act, it no doubt is an efficient auxiliary to the same end.

117. *The flexor longus hallucis*[1] is a strong muscle at the back of the leg, overlain by two other flexors of the toes, presently to be described, which take origin from its side. It arises by two very distinct tendinous heads: the one, a median one from the posterior aspect of the femur, immediately between the two condyles: the other from the outer aspect of the external condyle of the femur, just below the origin of the preceding muscle. The deep flexor passes up between these two heads, or rather passes down from its origin.

The *flexor longus hallucis* now forms a large fusiform muscle at the back of the tibia overlying the deep flexor. At the lower third of the leg it comes to a gradual point, to terminate in a strong tendon, that passing beneath the more superficial flexors, in a special canal on the outer side of the *tibial cartilage*, goes through the outer and large canal of the hypotarsus, next to the shaft and directly down to the apex of the accessory

[1] "53*b*. M. FLEXOR HALLUCIS LONGUS.

Flexor hallucis longus. Gurlt, p. 31.
" " " De Man, p. 133, No. 22.
" " " Garrod, *P.Z.S.*, 1872, p. 363.
Flexor digitorum communis profundus (pt.). Quennerstedt, p. 45.
Le fléchisseur profond du pouce. Alix, p. 459.
Flexor perforans digitorum (pt.). Watson, p. 124." (Gadow, *loc. cit.*, p. 197.)

metatarsal bone. It winds round to the inner side of this, fits snugly in its groove beneath, then passes along on the under side of the shaft of the basal joint of hallux, to become finally inserted into the tubercle at the inferior proximal end of its ungual phalanx.

This muscle is a powerful flexor of the hind toe or hallux. When it contracts, however, it also acts upon other flexors of the toes, soon to be alluded to, so there is not absolute independence of action here.[1]

[1] Of the *flexor perforatus indicis secundus pedis* and the *flexor longus hallucis*, as they occur in *Geococcyx californianus*, I have said that:—

"The *flexor perforatus indicis secundus pedis* (Fig. 63 *bis*) is even a better developed muscle than I found it to be among typical Corvidæ, some of which I have recently dissected, and it is fully as well individualized.

"It arises from the fascia at the outer side of the knee-joint, and from the contiguous surface of the external condyle of the femur. Here it receives the anastomosing fibres of the extremity of the tendon of the *ambiens*.

"The muscle is fusiform in shape and accurately moulded on the flexor it covers at its side. Its tendon in descending the leg is thin and ribbon-like. At the ankle it passes through the tibial cartilage, and crossing the joint goes through, with the second tier of tendons, the cartilaginous cap on the back of the hypotarsus of the tarso-metatarsus. Passing down behind this latter bone, and through the annular ligament in the sole of the foot, it proceeds to the under side of the second toe, beneath the second phalanx of which it expands to form a tubular sheath for the passage of the deep flexor, while at the same time it becomes attached to the side of this joint of the toe in question.

"The carneous portion of this muscle in the leg is to the *outer* side of the loop for the *biceps flexor crucis*, and, owing to the fact that it varies in form and size in different birds, it is as well to bear this in mind.

"The *flexor longus hallucis* (Fig. 64 *bis*) has two separate heads, the one coming off from the outer side of the external condyle of the femur, and the other, far more fleshy, arising from the posterior aspect of the same bone between the condyles. Above, this muscle

Some ten years ago the late Professor Garrod contributed to the *Proceedings of the Zoological Society* a paper setting forth some of his very important and interesting investigations upon the deep plantar tendons in different birds.

He shows that there was considerable diversity among these tendons in the class, both in their behaviour in the sole of the foot, as well as at the back of the tarsometatarsus.

The tendons of the *flexor perforans digitorum*, and the present one, sometimes cross each other in certain birds in a peculiar though constant way; at others, these two tendons are united by a descending fibrous *vinculum*. "In all cases this vinculum is always directed downwards from the hallux muscle to the digits muscle, so that, when the tendon of the *flexor perforans digitorum* alone is pulled upon, the three

is overlapped by the more superficial flexors, while in turn it has beneath it the *flexor perforans digitorum profundus*. About half-way down the leg it gives way to a strong tendon, which, passing deep in the tibial cartilage, crosses the ankle-joint to pass through the outer canal of the osseous portion of the hypotarsus of the tarsometatarsus. Down the back of the shaft of this latter bone the tendon exhibits a disposition to develop an osseous rod in its continuity, but this does not actually occur in my specimen. It lies in this region just above the tendon of the deep flexor, and, immediately above the sole, makes a fibrous connection with it of some extent. This fibrous 'vinculum' is in no way oblique as it is described by Garrod for many birds, but passes directly from one tendon to the other for about eight millimetres, and were it not known that it as a rule passes obliquely *from* the *flexor longus hallucis*, it would be quite impossible here to designate which tendon was responsible for the connection.

"In the foot the long tendon of the *hallux* passes in the usual way to become inserted on the tubercle at the under side of the proximal end of the ungual phalanx." (See 120 of *Bibliography* at the end of this volume.)

anterior digits alone are flexed; but when the *flexor longus hallucis* is put in action, the digits as well as the hallux are simultaneously flexed" (*Coll. Memoirs*, p. 291). No such vinculum exists in the Raven, and in this particular it agrees with the Passeres and *Upupa epops*. Further studies in this direction will be very acceptable.

A few years ago I published the following remarks in reference to the variations to be seen in the arrangement of these plantar tendons, and the uses that could be made of them in avian taxonomy (124 of *Bibliography*). I said that "both Professor C. J. Sundevall and Professor Garrod have paid considerable attention to the disposition of these tendons in the feet of birds. If I mistake not, the first-named author was the writer who originally invited attention to the fact that the tendon of the *flexor longus hallucis* was completely independent of the tendon of the *flexor perforans digitorum profundus* in the Passeres; and in view of this fact he grouped these birds together, and as the Hoopoe (*Upupa*) exhibited the same condition, he included that form with them. Garrod pushed the matter much further, however, and made some very extensive dissections upon the deep plantar tendons in a great many different orders of birds.

"Irrespective of the plan of the foot, in all birds, in so far as its digits are concerned, there are two muscles present in the leg, which, arising from the tibia and fibula, send each a tendon to the toes as *flexors*: these muscles are the *flexor longus hallucis* and the *flexor perforans digitorum profundus*. In passing through or over the hypotarsus of the tarso-metatarsus, at the back of the ankle-joint, the tendon of the *flexor longus hallucis* is either *superficial* or *external* to the tendon of the other flexor mentioned.

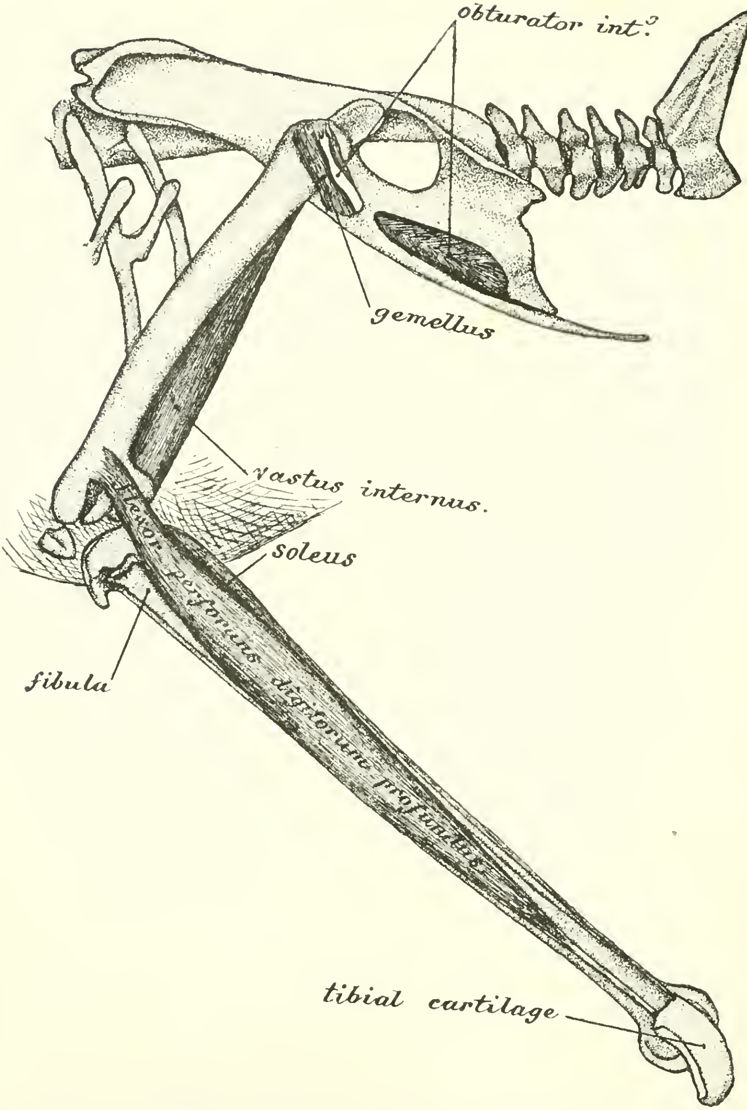

FIG. 65.—Outer aspect of the left pelvic limb of a Raven, showing the fourth or deepest layer of muscles of the thigh and leg. The under side of the *obturator internus* may be seen through the "obturator space," and its tendon surrounded by the *gemellus* attached to the trochanter of the femur. The tibia has been rotated in order to bring its posterior surface into view, and show the muscles there found; the "tibial cartilage" is seen at its distal extremity. Life-size, by the author, from his own dissections.

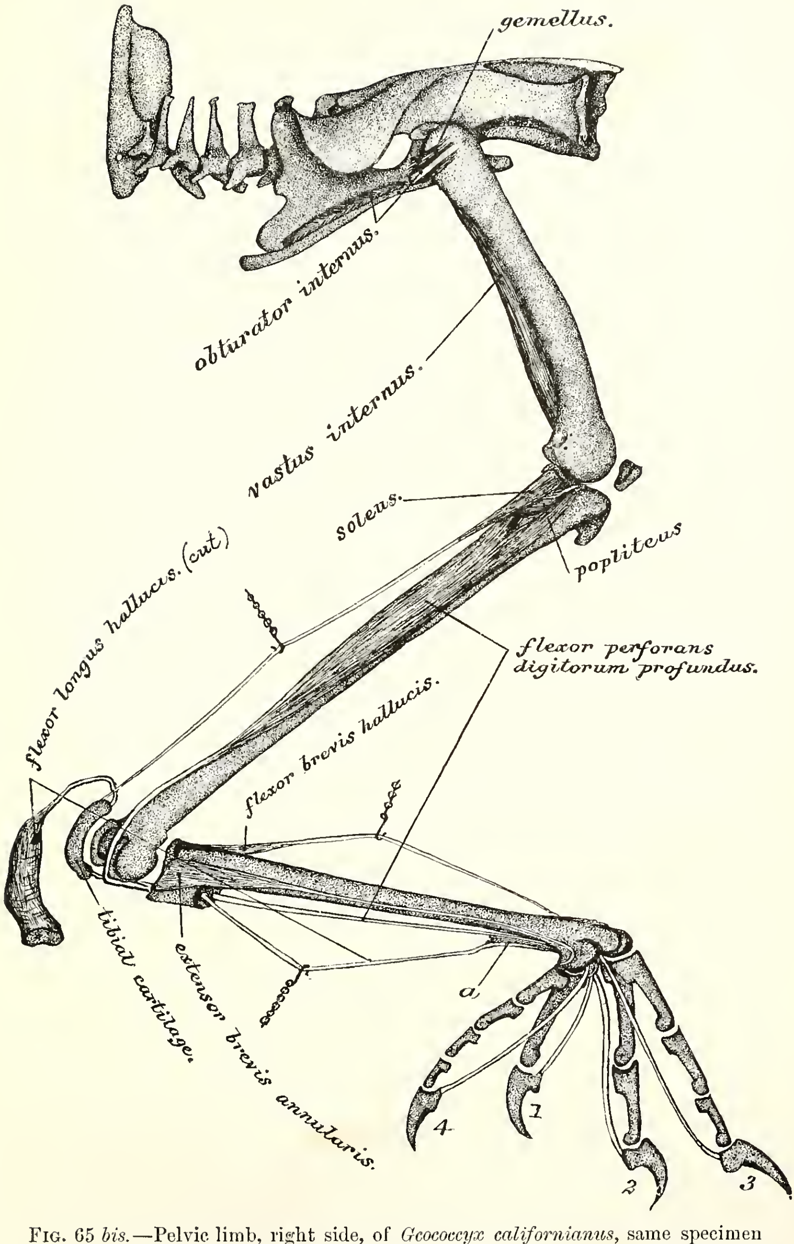

FIG. 65 *bis.*—Pelvic limb, right side, of *Geococcyx californianus*, same specimen as is shown in Figs. 62 *bis*, 63 *bis*, and 64 *bis*. The deepest muscles of all only are left, and the tendon of insertion of the *obturator internus* is distinctly seen. Life-size, by the author, from his own dissections.

"This fact is useful to be borne in mind in identifying these tendons in our dissections. Now after they pass a short distance down the back of the tarso-metatarsal bone their behaviour in different birds is quite diverse, and a few examples of it will be here presented in order to show that when our knowledge becomes more full in the premises, the character will prove a useful one in classification of birds; and also it is hoped to induce those interested in the science of anatomy to undertake and carefully record researches upon this subject. Before arriving at the podal phalanges, and in the sole of the foot of any bird, these tendons divide into a sufficient number of slips to be distributed to the former, one slip going to each toe. The method of division is the same for the bulk of avian families, and the more universal type is well exemplified in the Common Chicken (*Gallus*).

"Fig. 65 *quat.* of this paper shows this arrangement in the Fowl, and there we observe that the tendon of the flexor to the first toe is *external* to the tendon of the *flexor perforans digitorum profundus* as it passes the ankle-joint.

"At the back of the tarsus it crosses the latter superficially, and then passing directly to the under side of the hind-toe it becomes inserted into the base of its ungual phalanx.

"Now the larger tendon of the *f. p. digitorum profundus*, after arriving at the sole of the foot, trifurcates, and a slip is sent to the under side of each anterior toe, where passing forwards they too become inserted at the bases of the ungual digits of the respective phalanges. Just above this trifurcation the tendons of these two muscles however, are connected, and that by a fibrous *vinculum* (Fig. 65 *quat.*, *Vn*) which passes between them.

"The fibres of this vinculum come off from the tendon of the *flexor longus hallucis,* and pass downwards to soon merge with the fibres of the tendon of the *flexor perforans digitorum profundus* at the crossing.

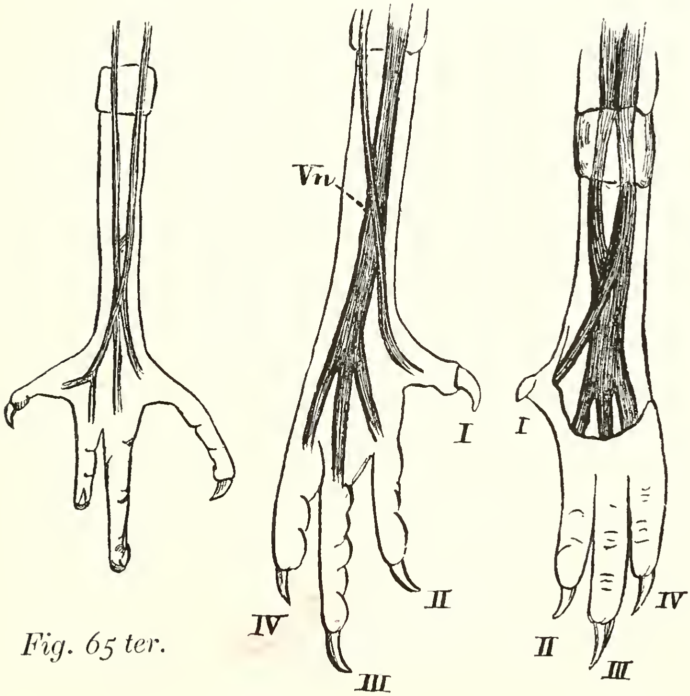

Fig. 65 ter. *Fig. 65 quat.* *Fig. 65 quin.*

FIG. 65 *ter.*—Right foot of *Megalæma asiatica,* showing an arrangement of the plantar tendons.
FIG. 65 *quat.*—Left foot of *Gallus bankiva.* *Vn,* vinculum running downwards from the outer hallucial tendon to the inner digital common tendon.
FIG. 65 *quin.*—Right foot of *Apteryx mantelli.* (All three figures copied by the author from Garrod.)

"The strength and size of the vinculum is different in nearly every group of birds where it is present. In Fig. 65 *bis,* at *a,* I have shown the position and size of

this vinculum as I found it to be present in the Ground Cuckoo.

"In order to show how different this disposition of these plantar tendons may be, I quote Garrod's description of his dissection of the foot of a specimen of *Megalæma asiatica* (Fig. 65 *ter.*). He says, in this bird 'the two tendons descend behind the ankle as usual, having their origins typical. There is nothing peculiar till they have descended two-thirds down the tarso-metatarse. About opposite the middle of that bone the *flexor longus hallucis* sends a vinculum downwards as in the Fowl, to join the tendon of the *flexor perforans digitorum.* Just above the metatarso-phalangeal articulation the tendons become arranged for distribution in a most uncommon manner. The tendon of the *flexor perforans digitorum* does not split up, but runs to one digit only—namely, the third toe, which is the outer of the two that are directed forward. It is covered superficially by the *flexor perforans digitorum,* just as that latter muscle is splitting up to be distributed to the hallux as well as to digits 2 and 4. In these birds we have, therefore, the *flexor longus hallucis* arising from the lower surface of the femur only, running through the ankle at the outer side of the other deep tendon, and sending a vinculum downwards—all of which are special characters of that muscle only, it being distributed to three toes, whilst the *flexor perforans digitorum* only supplies one.'

"In Fig. 65 *quin.* the arrangement in the *Apteryx* is well shown, where the vinculum is so large as compared with this band in the Fowl, that it almost appears upon sight that the two flexor tendons are fused into one common one, at the point of union.

"A close study of this arrangement, however, will throw

much light upon the variations as they are to be found in the less typical birds in this respect."

118. *The flexor perforatus annularis primus pedis* [1] arises from the inner side of the belly of the *flexor longus hallucis,* about a centimetre below its median head, some of the fibres of its flat tendon being undoubtedly carried up to the insertion of the latter muscle. It passes directly down the back of the leg as a long, laterally compressed, rather slender muscle.

[1] In introducing the term "*annularis*" into the name of this muscle, the writer does so simply with the view of impressing upon the mind the relation or position the toe bears with reference to the corresponding finger of the hand, *i.e.* in five-fingered and five-toed vertebrates. A distinctive name is pretty sure to do this. I am greatly pleased with the names Gadow has conceived for these flexor muscles in the feet of birds, and if what the names signify holds true for the class, they are deserving of very general adoption. No one will question the boon it would prove to be to have a commonly accepted nomenclature for them (No. 118 is 51*c* of Gadow).

"51*c*. M. FLEXOR PERFORATUS DIGITI IV.

Le fléchisseur commun (*ou perforé*). Vicq d'Azyr, 283, No. 3; Cuvier, 558.

Flexor perforatus digiti externi. Wiedemann, p. 104.

" " " " Tiedemann, § 311.

" " " " Watson, p. 121.

Langer Zehenbeuger; innerer Kopf. Meckel, *Archiv*, 277, No. 4.

Einer der Spulmuskeln. Meckel, *System*, 382–386, No. 2.

Flexor communis quattuor digitorum s. sublimis (pt.). d'Alton, p. 37.

Flexor perforatus (pt.). Reid, p. 144.

Flexor sublimis s. perforatus digiti quarti. Gurlt, p. 31.

Flexor perforatus of the outer toe, s. longus digitorum (pt.). Owen.

Flexor perforatus digitorum (äusserer Kopf). De Man, 131, No. 20.

Fléchisseur perforé, couche profonde (pt.). Gervais et Alix, p. 36.

Fléchisseur superficiel du doigt externe (*ou quatrième doigt*). Alix, pp. 458 et 460.

Flexor digitorum sublimis. Quennerstedt, p. 42; Neander, p. 25.

Flexor perforatus digiti IV. Gadow, No. 38."

It terminates in a flattened tendon at the lower third of the tibia, which is closely applied to a similar tendon coming from the *flexor perforatus medius primus pedis*, and the two pass together through the tibial cartilage, rather to its outer side, in a special canal. Crossing the ankle-joint, they also pass together through a canal in the hypotarsus situated at its upper and outer angle.

At the back of the shaft of the tarso-metatarsus these tendons part company, the tendon of the *flexor perforatus medius secundus pedis* passing between them obliquely.

The tendon of the muscle now under consideration makes straight for the under side of the outer toe. Here it forms a tubular sheath, through which the deep flexor runs, and opposite the short shafts of the basal phalanx and the joint next beyond, it sends down on either side a tendinous slip, which in each case attaches to these bones. Thus fulfilling, we see, the part, too, of a *secundus flexor* of this toe.

119. *The flexor perforatus medius primus pedis*[1] arises from the inner side of the carneous portion of

[1] Referring to the synonymy of this muscle as compiled by Gadow, we are enabled to record the following upon the subject (*loc. cit.*, p. 188):—

"51*b*. M. FLEXOR PERFORATUS DIGITI III.

Le fléchisseur commun (*ou perforé*) (pt.). Vicq d'Azyr, p. 283, No. 3; Cuvier, p. 558.

Zusammenzieher der Zehen (pt.). Merrem, p. 161, No. 7.

Flexor perforatus digiti medii. Wiedemann, p. 103.

" " " " Tiedemann, § 310.

" " " " Watson, p. 121.

Langer Zehenbeuger, äusserer Kopf. Meckel, *Archiv*, p. 277, No. 4.

Einer der Spulmuskeln. Meckel, *System*, pp. 382–386, No. 2.

the last-described muscle close up to its head. It is considerably smaller in size, and its outer fascia sooner terminates in its flattened tendon. This takes its course, as I have already described, closely applied to the *flexor perforatus annularis primus pedis*, through the tibial cartilage and hypotarsus of the tarso-metatarsus. Arriving at the palmar aspect of the basal joint of the third toe, it sends down a slip to either side of its shaft, which thus forms a guide for the passage of the two deeper flexors which glide between them.

The carneous portions of the three last-described muscles are quite intimately bound together by a close-fitting and firm fascia. So that there is considerable unison in their action, but, as we have seen, the course of their tendons is more or less independent. If it were possible to keep the distribution and insertion of these tendons in our mind, it would not be far out of place to speak of their common muscular portion as the *flexor perforatus primus pedis.*

120. *The flexor perforatus medius secundis pedis* [1]

Flexor communis quattuor digitorum s. sublimis (pt.). d'Alton, p. 37.
Flexor digiti secundi et tertii brevior (pt.). Gurlt, p. 31.
Flexor perforatus s. longus digitorum (pt.). Owen.
Flexor perforatus digitorum (innerer Kopf). De Man, p. 131, No. 20.
Fléchisseur perforé, couche profonde (pt.). Gervais et Alix, p. 36.
Fléchisseur de la deuxième phalange du doigt interne (Struthio); *du doigt troisième* (Ardea). Alix, pp. 457 et 460.
Flexor digitorum sublimis (pt.). Quennerstedt, p. 42; Neander p. 25.
Flexor perforatus digiti III. Gadow, No. 37."

[1] The synonymy of Gadow is thus recorded (*loc. cit.*, p. 192):—

"52*b*. M. FLEXOR PERFORANS ET PERFORATUS DIGITI III.
M. sextus circa tibiam et fibulam. Steno.
Fléchisseur perforant et perforé (pt.). Vicq d'Azyr, 284, No. 4.

is one of the largest of these perforated flexors the tendons of which go to the toes.

It is found at the antero-external aspect of the leg, and arises by a strong fascia that merges with the fascia of the knee-joint. It also arises by a strong tendon, in common with the tendon of the *flexor perforatus indicis secundus pedis*, from the outer side of the external condyle of the femur. The muscles of the anterior aspect of the tibia also blend with it, more or less above, by a common fascia; while below we find it has a semi-tendinous attachment with the lower end of the fibula, and a line on the tibial shaft for a short distance below it.

Le muscle perforant et perforé (pt.). Cuvier, p. 553.

Fingerschliesser. Merrem, p. 161, No. 8.

Flexor perforans et perforatus digiti medii. Wiedemann, p. 102; Tiedemann, § 314; Watson, p. 123.

Zweiter vorderer Kopf des durchbohrten Beugers. Meckel, *System*, p. 380, No. 1.

Erster vorderer Kopf des durchbohrten Beugers. Meckel, *Archiv*, p. 276, No. 3.

Flexor digitorum sublimis s. perforatus (pt.). Gurlt, p. 31.

Flexor perforatus (pt.). Reid, p. 144.

Flexor perforatus s. longus digitorum (pt.). Owen.

Der besondere Beuger des ersten Gliedes der dritten Zehe. Carus, Erläuterungstafeln.

Flexor digiti II. et III. (*perforans et perforatus*) (pt.). Quennerstedt, p. 40; Neander, p. 24.

Fléchisseur perforé, couche superficielle (pt.). Gervais et Alix, p. 37.

Fléchisseur de la troisième phalange du doigt interne (Struthio) *troisième.* Alix, pp. 457 et 460.

Flexor perforans et perforatus digiti medii. De Man, p. 134, No. 23.

M. flexor perforans et perforatus digiti III. Gadow, No. 35.

Flexor perforans et perforatus digiti medii. Watson, p. 123."

Note.—The accounts of the flexors and extensors of the toes in birds as given by Prof. Gadow in Bronn's *Thier-Reichs* can very profitably be compared with the musculature of the Raven.

From this extensive origin, this large and fusiform muscle, covering the fibular region, terminates at the lower third of the leg in a strong and somewhat flattened tendon. This passes obliquely and very superficially through the tibial cartilage from without inwards to the hypotarsus, where it passes through the interno-posterior canal, then accompanies the other tendons at the back of the metatarsus, to deviate and go to the second joint of the middle toe, having perforated the tendon of the basal phalanx *en passant*. Its method of attachment to this prebasal joint is precisely the same as for the corresponding tendons of the other podal digits described above.

121. *The flexor perforatus indicis primus pedis*[1]

[1] This is the *flexor perforatus digiti II.* of Prof. Gadow's nomenclature, and he gives the following synonymy for it (*loc. cit.*, p. 187):—

"51*a*. M. FLEXOR PERFORATUS DIGITI II.

Le fléchisseur du doigt interne. Vicq d'Azyr, p. 289, No. 3.
Fléchisseur commun (*ou perforé*) (pt.). Vicq d'Azyr (?); Cuvier, 558.
Flexor profundus phalangis I. digiti interni. Wiedemann, p. 105.
,, ,, ,, ,, ,, ,, Tiedemann, § 313.
,, ,, ,, ,, ,, ,, De Man, p. 133, No. 21.
Einer der Spulmuskeln (?). Meckel, *System*, pp. 382–386, No. 2.
Flexor communis quattuor digitorum s. sublimis (pt.). d'Alton, p. 37.
Flexor digiti secundi et tertii brevior (pt.). Gurlt, p. 31.
Flexor perforatus (pt.). Reid, p. 144.
Flexor perforatus s. longus digitorum (pt.). Owen.
Fléchisseur perforé, couche profonde (pt.). Gervais et Alix, p. 36.
Fléchisseur de la deuxième phalange du deuxième doigt. Alix, p. 460.
Flexor digitorum sublimis. Quennerstedt, p. 42.
,, ,, ,, Neander, p. 25.
M. perforatus digiti II. Gadow, No. 36.
Flexor perforatus digiti interni. Watson, p. 120."

Gadow seems to have set to work at his analysis of the muscula-

is situated posterior to the preceding, and is a long, slender, somewhat flattened, fusiform muscle, whose office it is to assist in flexing the second toe. Laterally its fascia blends, more or less, with the flexors on either side of it; still, the muscle is well-individualized, and fully entitled to a separate description and name. It arises by a thin and rather broad tendon, in common with the *flexor perforatus medius secundus pedis*, from the external condyle of the femur. Below, it terminates in a strong though slender tendon, before the last-named muscle does, and passes through the tibial cartilage and hypotarsus of the metatarsus in precisely the same manner, though in each case in a canal deep to it.

In accompanying the other flexor tendons down the back of the shaft of the tarso-metatarsus, it is found rather to the inner side. Within the region of the sole of the foot it is situated very deep, and just within the accessory metatarsal bone. It finally becomes attached to the sides of the basal joint of the second toe, in the same manner as the other perforated tendons in the other toes, the *secundus* and deep ones passing through its median bifurcation.

122. *The flexor perforans digitorum profundus* [1] is, in point of situation, the deepest of all the flexor

ture of the feet in Aves very much in the same manner as did the present writer, and his valuable chapter on the subject in the work we have so often quoted in the present volume is well worthy of the closest study and perusal.

[1] We have here a very important muscle of the leg, and one that was thoroughly investigated by Garrod at the time he was in search of structural characters among birds that could efficiently be employed as a means in classification.

Gadow has collected together the following synonymy for it, and in his work in Bronn's *Thier-Reichs* gives quite a full *résumé* of the

muscles at the back of the tibia (see Figs. 46, 52, 59, 60, and others).

Its highest origin is by a strong, fleshy head from the posterior aspect of the external condyle of the femur. Two other fairly defined heads of this muscle come off from the tibia behind, just below its summit; the inner one being close to the origin of the *soleus*. This deep flexor also arises from the major portion of the posterior surface of the tibial shaft (Fig. 52) as well as from the fibula. In form, it is flattened, with a strong fascia covering its exposed or external surface, extending nearly its whole length from the femoral head. At the lower third of the tibia it terminates

variations the *flexor dig. profundus* takes on in the various groups of birds (*loc. cit.*, pp. 193–196):—

"53*a*. M. FLEXOR PROFUNDUS S. PERFORANS.

M. secundus posterior digitos movens. Aldrovandi.

M. octavus posterior circa tibiam et fibulam. Steno.

Le fléchisseur perforant. Vicq d'Azyr, p. 284; Cuvier, p. 558.

Zweiköpfiger Muskel. Merrem, p. 161.

Flexor profundus s. perforans trifidus. Wiedemann, p. 104.

Flexor profundus s. perforus trifidus. Tiedemann, § 312.

Durchbohrender oder tiefer durchbohrender Beuger. Meckel, *System*, p. 386–390, No. 3; *Archiv*, 278–279, No. 5.

Flexor profundus s. perforans; flexor communis IV. dig. s. sublimis pars post. d'Alton, p. 38.

Flexor digitorum longus s. perforans. Gurlt, p. 31.

Flexor perforans digitorum. Owen, *Cyclop.*, p. 297; *Apteryx*, p. 295; De Man, p. 130, No. 19; Watson, p. 124.

Flexor digitorum communis profundus. Quennerstedt, p. 45; Neander, p. 27.

Flexor perforans. Reid, p. 144.

Fléchisseur profond. Gervais et Alix, p. 35.

Fléchisseur profond, perforant ou commun des trois doigts proprement dits. Alix, p. 459.

Flexor profundus. Garrod, *Proc. Zool. Soc.*, 1872, p. 363; Gadow, No. 39."

in a powerful and flattened tendon, which passes, nearly in the median line, through the *tibial cartilage*, deep to all the other flexors. In traversing the hypotarsal prominence it selects the large outer canal next to the shaft; and in emerging from it, its tendon, in passing down the back of the shaft of the tarso-metatarsus, is nearest the bone. It also develops in it, in this locality, a strong osseous rod, just below which its trifurcation takes place. Each division as it leaves the main trunk in the sole of the foot, proceeds directly to one of the anterior toes, to pass its entire length along its palmar aspect. In effecting this, it lies close to the several joints, and perforates the other flexor tendons in a manner already described. Arriving at the ungual phalanges, in each case, the tendon attaches itself to the proximal tubercle at the base upon its under side. These several tendons are also held in position by strong fasciæ which bind them to the under side of the toes ; and these must be slit up with our scalpel before they are exposed.

This muscle, as may be seen both from its origin and insertion, is the most powerful of all the flexors of the toes; the others being, more correctly speaking, simply auxiliaries to its action.

After the integuments have been removed, the form of the leg is quite conical, being, however, somewhat compressed laterally, while its base may be said to be at the knee-joint, and its apex at the condyles of the tibia.

All the flexors we have described above are more or less intimately connected together by binding fascia, and this applies also, to a great extent, to the group of muscles upon the anterior aspect of this division of the pelvic limb; while the whole seems to be enveloped

in a firm sheath of connective tissue, which masks at first sight the individuality of the several muscles.

For a centimetre or more above the tibial condyles we observe their numerous tendons, as they start from the lower apices of these different muscles ; while in the division of the limb next below, we find the flexors at the posterior aspect of the tarso-metatarsal shaft snugly wrapped in fascia, and bound to the bone as a subcylindrical bundle of tendons, the several factors of which enjoy perfect freedom of action in the longitudinal direction. The extensor tendons and the short extensor muscle and other elements are somewhat differently circumstanced in front in the very nature of their requirements, but here, too, a fascia surrounds them in a similar fashion, drawing them up snugly by the shaft of the bone.[1]

[1] In the second volume of his *Anatomy of Vertebrates*, Professor Owen describes for the *Apteryx* (p. 104) a *popliteus* muscle, and says it "is brought into view when the superficial muscles of the leg which are inserted into the foot are removed. Its carneous fibres extend from the fibula inward and downward to the tibia. It is of relatively smaller extent than in the Cassowary." Professor Mivart also alludes to the occurrence of this muscle in birds in his *Elementary Anatomy*, but I must confess that after careful search in a number of individuals, I have signally failed to find the *popliteus* in the Raven. And I am rather inclined to believe that it will be found to be absent in the higher groups of birds. It is present in the Echidna.

Since writing the foregoing paragraph of this footnote, I find the following remarks and synonymy in Gadow on the *popliteus* muscle in birds (*loc. cit.*, pp. 176, 177). He does not mention it as occurring in the *Corvidæ*.

"44. M. POPLITEUS.

Le muscle poplité. Vicq d'Azyr, p. 514.
Poplitæus. Wiedemann, p. 99.
Popliteus. Tiedemann, § 303.

We find a well-developed *popliteus* muscle in *Geococcyx californianus*, where it is seen to arise from an oblique line on the back of the tibial shaft below the head of the bone, and the fibres converging to pass upwards and outwards are inserted by a short tendon into the corresponding aspect of the head of the fibula, close to the superior fibres of insertion of the *flexor perforans digitorum profundus*.

The several flexor muscles of the pelvic limb of the Raven which we have been describing in the last few pages can be compared with great profit with the corresponding muscles as they occur in a bird with zygodactyle feet. The species to which we have been referring for that purpose in this work is *Geococcyx californianus*, and, as has already been noted, the writer presented some observations upon its myology in the *Proceedings of the Zoological Society of London* for 1886. From that paper I here republish my remarks upon these flexor muscles as they were found to exist by me in *Geococcyx*, in order that the comparisons can be made which have been suggested above. I remarked that in *Geococcyx*

Popliteus. Owen.
,, Quennerstedt, p. 36.
,, Neander, p. 21.
,, Gadow, No. 28.
,, Watson, p. 116.
Kniekehlenmuskel. Meckel, *System*, p. 369, No. 2; *Archiv*, p. 272, No. 11.
Le poplité. Gervais et Alix, p. 33.

. . . .

"Ausserordentlich klein ist der *M. popliteus* bei den kletternden Vögeln, auch bei *Cuculus*, wahrscheinlich ganz fehlend bei *Psittacus*, *Picus*, und *Cypselus*. Dagegen ist er recht ansehnlich bei *Caprimulgus*, *Strix*, *Buteo*, *Gallus*, *Numenius*. Schwach bei *Anser*, *Grus*, *Fulica*, *Larus*, *Colymbus*, *Ciconia*, *Serpentarius*."

"the *flexor perforatus annularis primus pedis* (compare Figs. 63 *bis* with 65 *bis*) in this bird seems to have acquired a more central position on the back of the leg than in many others that I have dissected, and, moreover, its tendon, as will be seen from the figures, is quite superficial.

"It arises from between the condyles of the femur by a slight semitendinous slip, and from the side of the *flexor longus hallucis.* The muscle itself is somewhat of a fusiform outline and rather flat; it lies to the *inner* side of the loop for the *biceps.* About one-third of the way down the back of the leg it terminates in a small though very long tendon, which, passing quite superficially through the tibial cartilage and over the ankle-joint and hypotarsus, runs in common with the other flexors down the back of the tarso-metatarsus, turns to the rear in the sole of the foot to become inserted on the under side of the distal end of the basal phalanx of the reversed digit. In the specimen before me this insertion is to the outer side of the deep flexor, and the tendon is not slit for its passage. Nothing could be more engaging than the examination of these *reversed* tendons in the sole of the foot of this Ground Cuckoo, for the greatest nicety in accommodation has been accomplished as they have gradually come to assume their present position. No doubt some of the departures observed from the more common arrangement of them are due to the reversion of the digit in question.

"Strong, fibrous bands are so disposed in this plantar region as to admirably hold the several groups of flexor tendons in place, and at the same time they act as pulleys for their guidance and afford correct application of the force intended to flex the toes.

"We also have in *Geococcyx* an unusually large *flexor*

perforatus medius primus pedis, which here arises by two slips, an outer tendinous one, from the external condyle of the femur, which has a common origin with other muscles there arising, and is intimately connected with the dense fascia about the front of the knee-joint; while the second slip arises from between the femoral condyles, in common with other flexors that come off from that point. The two heads are quite independent, but merge with each other before they terminate in their common tendon at the lower third of the tibial shaft.

"It passes through the tibial cartilage, overlain by, but in close company with, the far more diminutive and narrower tendon of the *flexor perforatus annularis primus pedis.*

"When it arrives under the basal phalanx of the median toe, the outer one of the anterior pair, it bifurcates to allow the other two flexor tendons to pass, while the slips thus formed become attached to the sides of the shaft of this joint close to its distal head.

"It will at once be seen that *Geococcyx californianus*, in common with the vast majority of birds, has no special tendon devoted to the flexing of the *second* or prebasal phalanx of the *fourth* toe (here the reversed one). Provision is made for this in various ways in different birds. Here, in the subject before us, a special slip is thrown off for attachment from the deep flexor tendon as it passes over the prebasal joint in question, which slip virtually fulfils the function of a *flexor perforatus annularis secundus pedis*, did such a muscle with an independent tendon exist.

"The *flexor perforatus medius secundus pedis*, as in all of the birds I have examined, is one of the best developed perforated tendons at the back of the leg. Its fascia of origin merges with the enveloping fascia about

the knee-joint, while it also arises by a strong tendon, common to it and the *flexor perforatus indicis secundus pedis*, from the external aspect of the outer condyle of the femur.

"Finally, it is attached more or less by carneous fibres down the shafts of the leg-bones to a point below their middle, or rather the middle of the leg. Below this the muscle terminates in a strong tendon, which, taking an oblique course through the tibial cartilage, passes as usual over the ankle-joint, through the hypotarsus, and down the back of the tarso-metatarsus.

"In the foot it perforates the more superficial flexor of the basal phalanx of the outermost of the two anterior toes, then in turn bifurcates over the prebasal joint to allow the deep flexor to pass through, these bifurcations becoming the insertions of this muscle, and they are attached to the sides of the shaft of the second joint of the toe alluded to, or the external one of the two in front.

"As its name indicates, our next muscle, the *flexor perforatus indicis primus pedis*, has its tendon attached to the nether side of the basal phalanx of the index digit, and consequently aids in bending that toe.

"Above, as a flat, long muscle, it comes off by a thin tendon from the external surface of the outer femoral condyle, arising with the *flexor perforatus medius secundus pedis.*

"The *flexor perforans digitorum profundus.* This muscle is deep to all the flexors, and is situated directly on the posterior aspect of the tibia and fibula. It arises by two heads, one from the upper part of the tibia immediately below the overhanging rim of its summit,

and the other, smaller, from the back of the head of the fibula. In the Corvidæ there is a well-developed third head, which comes off from above the fibular notch of the outer condyle of the femur, and in these birds, too, there is no fibular head to this muscle, but two tibial ones instead. *Geococcyx* agrees, however, with most birds in having this muscle attached nearly the whole length of the posterior aspect of the shaft of the tibia by lightly attached carneous fibres.

"About a centimetre above the tibial cartilage it terminates in a strong subcompressed tendon, which, passing *beneath* the cartilage referred to, crosses the ankle-joint in front of all the other flexor tendons, and then passes through the inner of the two longitudinal perforations of the hypotarsal apophysis of the tarso-metatarsus. Down the posterior aspect of the shaft of this bone the tendon still maintains its anterior position and exhibits a predisposition to ossify. But this does not actually take place in the specimen before me. Above the distal trochleæ, it makes the fibrous connection with the tendon of the *flexor longus hallucis* already described. Once within the limits of the post-trochlear space, the tendon of this muscle behaves in a manner common to most birds—that is, it quadrifurcates, and each branch takes a course close up to the joints on their plantar aspects, and running through the slits in the perforated tendons pass in each case to the ends of the toes, where they become attached or inserted upon the infero-proximal tubercles of the ungual phalanges. The one passing along under the fourth digit sends up a slip which is attached to the under side of the shaft of the prebasal joint, thus making good the deficiency here for what is represented in the other toes by an independent tendon.

"The tibial head of this muscle at its origin is directly covered by the *soleus*, while in the aperture existing between the two heads we can discern the *popliteus*.

"These flexor muscles, and others on both the front and rear of this limb, are moulded upon each other in a manner that can only be justly appreciated by a personal examination. In some the connections are quite feeble, the intervening tissue being easily separable, while in others the intimacy is very close, and great care is demanded on the part of the investigator to see that the separation is made along the proper divisions.

"I am convinced from my studies that a greater difference is to be found among the various muscles of birds than we have ever accredited them with, and this fact leads me to believe that the day will come when these differences can be called into play in taxonomy with excellent effect. Perhaps if the myology of the leg is examined as carefully as Professor Garrod examined the muscles of the thigh in this class, fully as many interesting and valuable distinctions will come to light.

"As we pass the muscles we have described for this limb of *Geococcyx* in review, it will at once be recognized that the list is unusually complete. All the ordinary muscles of the thigh are present as found in birds, and all highly developed. In the leg marked specialization and organization are everywhere evident, while exceptional muscles are here, too, fully represented.

"This complexity by no means diminishes as we proceed towards the foot, for the arrangement of the tendons as they course down the tarso-metatarsus and the special musculature of this division of the limb is manifestly indicative of high organization.

"Finally, we have the complex insertional extremities

of the intricate system above laid before us in the foot; and the most exquisite examples of adaptation, compactness, and final requirements are to be seen throughout the structure on every hand.

"The *flexor brevis hallucis* is an exceedingly interesting little muscle. It arises from the side and the lower margin of the inner aspect of the hypotarsus of the tarso-metatarsus, and from some of the shaft of this bone immediately below. The fibres converge to terminate in a small tendon, which, passing down the postero-internal aspect of the shaft, goes to the inner side of the basal joint of the hallux, about which it winds, to finally become inserted on its under side, at the proximal extremity of this joint, just a little beyond its articulation with the tarso-metatarsal trochlea.

"Thus it will be seen that this little muscle is entirely devoted to assist in flexing the hallux. Its mesial fibres meet those of the muscle next to be described, down the mid-longitudinal line of the shaft of the bone which gives it origin.

"Equally engaging with the last is another still smaller muscle, the *extensor brevis annularis*, on the opposite side of the same bone. Here we find its origin is much the same as the *flexor brevis hallucis*, coming off from the external aspect of the hypotarsus and the shaft below. It soon terminates in an extremely delicate little tendon, which, passing directly down to the fourth or reversed toe, becomes inserted on the supero-inner aspect of the basal phalanx of this digit.

"By its contraction it will act as a direct extensor of this toe, a requirement no doubt made necessary through the feeble manner in which this digit is now served by the slip which goes to it from the common extensor of these phalanges.

"This tendon of the short extensor gets its leverage by the fascia which circularly binds down all the tendons of the flexors and extensors, just above the sole on the one side, and which passes above the distal trochleæ on the other."

IX. THE MUSCULATURE OF THE TRUNK.

A PECTORAL and a pelvic limb may now be removed from the same, say the left, side, and the opposite limbs are allowed to remain, in order that we may compare the relations existing between their muscles and the muscles of the trunk, which are to be described in the present section. Next, we carefully remove the entire remaining integuments from the cadaver of our specimen, cutting the dermal muscles as we do so, close to their origins. In preparing the neck for our investigations, we should carefully remove the trachea; all superfluous fat and connective tissue; and the vessels and œsophagus. At its cephalic extremity, we clear away the entire hyoidean apparatus, and with it any other structures that may stand in the way of our complete view of the method of attachment of the neck-muscles to the base of the cranium.

In speaking of the muscles of the vertebræ, Sir Richard Owen says that "the muscles of the cervical region are the most developed, as might be expected from the size and mobility of this part of the spine; the muscles which are situated on the dorsal and lumbar regions are, on the other hand, very indistinct, feeble, and but slightly carneous; they are not, however,

entirely wanting. In the Struthious and short-winged sea birds, in which the dorsal vertebræ are unfettered by anchylosis, these muscles are more fleshy and distinct, most so in the *Apteryx*" (*Anat. of Verts.*, vol. ii. pp. 84, 85).

From the fact that none of the muscles in the back of such a form as the Raven exactly correspond with the dorsal muscles of the Mammalia, and certainly not with the highly differentiated groups, or the several layers, as we find them in man, it is more than probable that in the present instance I shall be called upon to curtail and simplify their nomenclature, and bestow upon certain ones provisional names, which they may wear until such times as our knowledge of the myology of the Vertebrata in general is far more extensive than it is at the present time.

We may hope for some light upon the question of such homologies only through exhaustive and comparative studies of the entire muscular systems of the Struthious forms of existing birds, and such other types as *Echidna*, the Duckbill, certain Fish forms, with such living Reptiles as are known to approach these in their structure. At the best, the unravelling of these homologies is an exceedingly difficult task, and one that demands all our patience, as well as our keenest insight into morphological problems. Not a little has already been accomplished in the direction I point out, but very little as compared with the enormous amount of exhaustive comparative work that still remains in such fields, for the hands and minds of the generations to come.

We find in most existing Chelonians that these muscles of the dorsum have almost entirely disappeared; while among the Snakes they are highly developed both as regards complexity and differentiation. In living

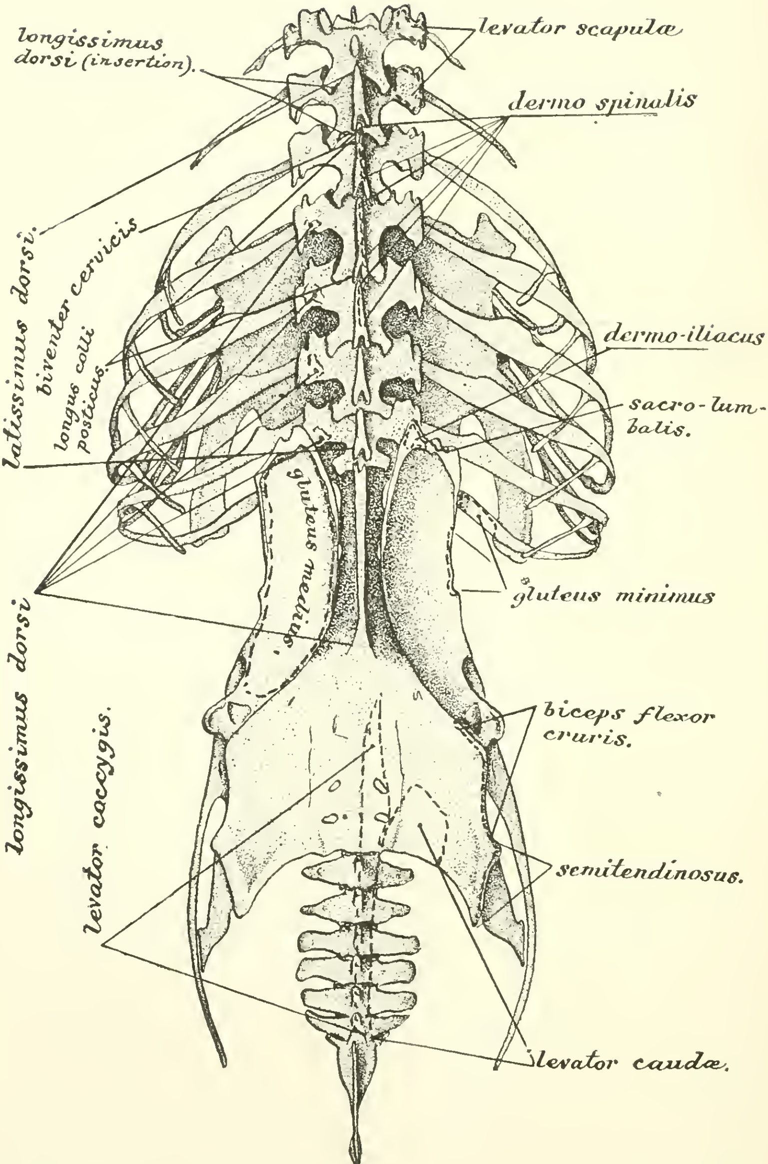

FIG. 66.—Dorsal aspect of the skeleton of the trunk in a Raven. Designed to show the origin and insertion of certain muscles thereto pertaining. Drawn life-size, by the author, from his own dissections.

Teleosts among fishes they form a bulky mass that goes to be inserted at the back of the cranium.

No less interesting is the study of the group of *caudal muscles* in this Raven, as compared with several of the forms suggested above. In a bird as high in the scale of organization as our present subject, of course, these muscles now all subserve the special movements of no less important an instrument to the performance of flight than the tail. With many of our existing Lizards, however, the tail must be considered more in the light of an ornament rather than an essential part in the economy. For instance, our little *Anolis* seems to get along quite as well when this appendage is broken off short with his body as he does with it; whereas I dare say such a curtailment in the *Archæopteryx* of the Jurassic would have proved a very serious accident, if not a fatal one in many cases.

Again, even in the Mammalia, as in the ring-tailed Monkeys, we find the tail a very useful and important organ, and in them the caudal muscles and their tendons are powerfully developed to meet the special ends of the act of caudal prehension.

Splendid demonstrations of this group of muscles in existing Lizards are to be seen in Mr. Mivart's memoir "On the Myology of *Chamæleon parsonii*" (*P.Z.S.*, December 6, 1870, p. 850), and his "Myology of *Iguana tuberculata*" (*ibid.*, 1867, p. 766); as well as in Mr. Alfred Sanders's "Myology of *Liolepis belli*" (*P.Z.S.*, 1872, p. 154), and the "Myology of *Phrynosoma coronatum*," by the same author (*P.Z.S.*, 1874, p. 71).

In speaking of these muscles in a general way, Mivart says that "A whole series of muscles may be developed

which in man are entirely absent. These muscles are the numerous muscles which move the tail, and which may attain a vast bulk, as in the Cetacea and in Fishes. To describe these muscles in detail would rather come within the scope of a treatise on the comparative anatomy of animals than within that of the present work. Here, however, it may be stated that the enormous coccyx of the Porpoise is provided not only with the dorsal muscles which continue on backwards the erector spinæ (with its main divisions) from the occiput to the tail end, but also possesses a ventral muscular mass (extending forwards as far as the middle of the thorax), which mass is divisible from above downwards into two antero-posteriorly extended masses—together constituting, as it were, a ventral (and here subvertebral) reflection of the erector spinæ. The same appearance occurs in some Reptiles and in Tailed Batrachians, where the ventral muscles of the tail repeat below, the dorsal masses above. But these Batrachian caudal muscles are not subvertebral—not the continuation backwards of subvertebral ones of the trunk, but direct continuations backwards of the abdominal muscles, as is also the case in most Fishes" (*Elem. Anat.*, pp. 323, 324).

It may be said here *à propos* to these remarks that the subvertebral caudal muscles are, as a rule, but feebly developed in the higher groups of birds, unless some special habit of the form demands them, as we know to be the case in the Woodpeckers.

The following muscles in the trunk of the Raven present themselves for our examination:—

123. The complexus.
124. The rectus capitis anticus minor.
125. The flexor capitis inferior.
126. The rectus capitis posticus major.

127. The biventer cervicis.
128. The longus colli posticus.
129. The sacro-lumbalis.
130. The longissimus dorsi.
131. The obliquus colli.
132. The longus colli anterior.
133. The rectus capitis lateralis.
134. The trachelo-mastoideus.
135. The interspinales.
136. The interarticulares.
137. The obliquo-transversales.
138. The intertransversales.
139. The triangularis sterni.
140. The intercostales.
141. The scalenus medius.
142. The levatores costarum.
143. The appendico-costales.
144. The obliquus externus abdominis.
145. The obliquus internus abdominis.
146. The rectus abdominis.
147. The transversalis abdominis.
148. The diaphragm.
149. The levator coccygis.
150. The levator caudæ.
151. The transversus perinei.
152. The depressor caudæ.
153. The depressor coccygis.
154. The lateralis caudæ.
155. The lateralis coccygis.
156. The infracoccygis.

123. *The complexus*[1] in the Raven, as in the vast

[1] For the following synonymy and remarks I am indebted to Gadow (*loc. cit.*, p. 109) :—

"6. M. COMPLEXUS.

Complexus. Vicq d'Azyr, 1773, p. 581, No. 5.
Der Kopfdreher. Merrem.
Grand complexus. Cuvier; Gervais et Alix, p. 15.
Der durchflochtere Muskel. Meckel, *System*, p. 297, No. 2.
Bauschmuskel des Kopfes (*Splenius*). Wiedemann, p. 75.
Bauschähnlicher Muskel. Tiedemann, p. 282.
Complexus. d'Alton, p. 7.
,, Owen, *Cyclopædia*, p. 291.
,, Selenka, p. 98, No. 14.
,, Watson, p. 62.

"Dieser Muskel gehört mit dem *M. biventer* zur oberflächlichen, selbstständig gewordenen Schicht des *M. semispinalis* in der oberen Halsregion. Er entspringt bei *Colymbus* sehnig von der Endsehne des *M. semispinalis cervicis* in Höhe des 5 Halswirbels, mehr fleischig von den *Intertransversarii posteriores* und mit einem kurzen besonderen Zacken von den *Proc. obliqui* des 4 und 3 Wirbels. Sein

majority of the class, is a very distinct and well-developed muscle.

It is clearly illustrated in my Fig. 70, and its mode of origin and insertion in Figs. 4 and 69.

On either side of the neck, it arises by three tendinous slips, one each coming off from the fourth, fifth, and sixth cervical vertebræ, respectively. These several origins occur upon the transverse processes of these vertebræ, upon the supero-external aspects of the outer walls of the lateral canals (Fig. 68). The slips pass between the muscles of the region there found; and, becoming carneous, unite externally to form a broad sheet of muscular tissue, which, being superficial and overlying the muscles of the occipital region for the most part, passes round to meet in the median line the fellow of the opposite side, in a tough fascia, forming a raphe nearly two centimetres long. The two muscles thus blended are now inserted into the occiput, some two millimetres above the occipital ridge, as a thin tendinous

Ursprung liegt demnach zwischen dem *M. longus lateralis* und dem *M. semispinalis cervicis.* Der Muskel wird ziemlich breit und stark, wird nur vom *M. cutaneus colli* bedeckt, während er selbst den *M. rectus capitis posticus* nebst der Insertion des *M. biventer* überdeckt. Er inserirt sich an der queren Crista des oberen Randes der *Occipitalia,* in der Mittellinie mit dem der anderen Seite zusammenstossend.

"Bei den meisten *Spheniscidæ* entspringt er von den *Processus obliqui posteriores* des 5–3. Wirbels, bisweilen jedoch ist er auf zwei Wirbel beschränkt. Bei den meisten Vögeln kommt er vom 3 und 4 Halswirbel."

Note.—Gadow gives five coloured figures in his plates showing the muscles in the neck of various birds, and in these the *complexus* in the neck of *Colymbus septentrionalis* appears to be exactly as I describe it for the Raven; while in the figure of the same bird on another plate it appears to have a somewhat different origin (compare Taf. 18*a*, figs. 1 and 2; 18*b*, fig. 1).

sheet, the most superficial structure of the kind there found.

The semi-ligamentous fascia, connecting these two muscles in the median line, and extending forwards to become inserted into the occiput, seems to represent the only thing that birds can claim as the analogue of a *ligamentum nuchæ*. In man, it will be remembered, this important ligament is in the line of union between the two trapezii muscles, and passes between the neural spine of the seventh cervical vertebra and the mid-point of the "superior curved line" of the supra-occipital bone.

In Cormorants and the *Anhinga* a free bony "nuchal style" is found projecting from a mid-point upon the occiput, in the convexity upon either side of which a temporal muscle becomes inserted. I am under the impression that I have said elsewhere in my writings, and Coues has made the same statement (*Key*, second edition, pp. 723, 724), that this bony style of the Cormorants lies in the line of the analogue of the *ligamentum nuchæ* in birds. But it is evident that it cannot safely be compared in either case with the ligament in question as it occurs in the Mammalia. In short, in view of the fact that there is no evident necessity whatever for the development of such a support to the head in *Aves*, I must believe that the wisest step to adopt in the premises is to deny the occurrence of the *ligamentum nuchæ*, in their class, altogether.

124. *The rectus capitis anticus minor* is a muscle in the fore part of the neck in most birds, which has thus been named and described by both Gurlt and Owen. And if I be correct in my diagnosis of it in *Corvus*, I find it to arise in the Raven from the apices of the

hyapophyses of the second, third, and fourth cervical vertebræ, and winds round the lateral aspect of the neck in precisely the same manner as I described for the *complexus;* indeed, the opposed edges of these two muscles are closely connected by fascia as they reach each other, after which the present muscle passes up with it to become inserted along on the same continuous line just above the occipital ridge, and behind the bony *meatus auditorius* of the skull.

The tendinous slips of origin of the *rectus capitis anticus minor* pass between the *flexor capitis inferioris* and the *longus colli anterior*, being intimately connected with the latter, and arising in common with the former.[1]

[1] We obtain the following in reference to this muscle from Gadow (*loc. cit.* p. 120) :—

"16. M. RECTUS CAPITIS ANTICUS MINOR S. LATERALIS.

Le muscle droit (*et moyen*). Vicq d'Azyr, 1773, p. 582, No. 5.
Kopfbieger (pt.). Merrem.
Langer Kopfbeuger (pt.). Wiedemann, p. 76.
Flexor longus capitis. Tiedemann, § 210.
Vorderer, kleiner, gerader Kopfmuskel. Meckel, *System*, p. 299, No. 4.
Rectus capitis anticus minor. Gurlt, p. 17 ; Owen.
Trachelo-mastoideus. Owen, *Apteryx*, p. 285.
,, ,, Selenka, p. 100, No. 20.
,, ,, Watson, p. 64.
Occipito-sous-cervical. Gervais et Alix, p. 15.
Occipito-sous-vertébral. Alix, p. 382.

"Nicht so kräftig wie der ihn bedeckende *Rectus major.* Er setzt sich in der Regel aus drei bis vier deutlichen Theilen zusammen, die von der Ventralfläche des 2 bis 5 Wirbels entspringen, und sich alle zu einem Muskelbauche vereinigen, der mit einer kurzen, rundlichen Sehne sich an dem eigenthümlichen zitzenförmigen Tuber der Seiten-Unterfläche des *Occipitale basilare* befestigt, dicht hinter dem *Meatus auditorius.* Der betreffende Fortsatz ist nicht mit dem *Proc. Mastoideus* zu verwechseln, er könnte als *Proc. paramastoideus* bezeichnet werden."

125. *The flexor capitis inferior*[1] (Figs. 3, 4, and 67) might almost be described as an "azygos muscle," so intimately blended are the two in the median line.

It arises in common with the *rectus capitis anticus minor* from the apices of the hypapophyses of the second, third, and fourth cervical vertebræ, and in the present instance either the fascia or a delicate tendinous slip may even come off from the corresponding point on the atlas. The thin tendons of origin of this muscle soon become carneous as they pass forwards in somewhat of a bulky mass, uniting with the fellow of the opposite side, to their insertion. This latter occupies the entire triangular area offered by the basitemporal of the base of the cranium, the bounding lines of the muscle taking form therefrom, and in accordance therewith.

This muscle in its action is a direct flexor of the head upon the neck, whereas the *rectus capitis anticus*

[1] As a rule this muscle has been considered to be one of the *recti* muscles rather than a *flexor* of the head upon the neck which I really conceive it to be. Its synonyms are thus recorded by Gadow (*loc. cit.*, p. 120) :—

"15. M. RECTUS CAPITIS ANTICUS MAJOR S. MEDIALIS.

Le muscle (*droit et*) *moyen de la tête.* Vicq d'Azyr, 1773, p. 582, No. 5.

Kopfbieger (pt.). Merrem.

Langer Kopfbeuger (pt.). Wiedemann, p. 76.

Mittlerer Kopfbeuger (*Flexor medius capitis*). Tiedemann, § 209.

Droit antérieur. Cuvier.

" " Gervais et Alix, p. 15.

" " Alix, p. 382.

Rectus capitis anticus major. Gurlt, p. 17 : Owen, *Proc. Zool. Soc.*, 1842, p. 29 ; Watson, p. 64.

Recti capitis antici (*major et minor*). Selenka, p. 100, No. 20.

Vorderer, grosser, gerader Kopfmuskel. Meckel, *System*, p. 299, No. 3."

minor rather pulls it downwards, while the *complexus*, no doubt, is an auxiliary to the more powerful extensors found at the back of the neck.

The single carotid artery becomes nearly superficial in the median line, near the posterior apex of the present muscle, formed by the union of the two inferior flexors of the head, just described, being covered only by the nearly transparent common envelope of fascia.

It bifurcates soon after its emergence from the point in question, and each lateral branch is harboured in the sulcus formed by the present muscle and the *rectus capitis anticus minor*, until the vessel arrives at that foramen which affords it, on either side, ingress to the cranial cavity.

126. *The rectus capitis posticus major*[1] is, on either

[1] The only muscle I can find in literature wherewith to compare the present one is the *rect. cap. posticus* of Gadow, who presents us with the subjoined synonymy for it, and in Bronn's *Klassen des Thier-Reichs* (*loc. cit.*, p. 112) gives a description for it :—

"8. M. RECTUS CAPITIS POSTICUS.

Kleiner Kopfheber. Merrem.
Le petit muscle droit postérieur ; petit complexus. Cuvier.
Rectus capitis posticus major et minor. Tiedemann, § 205-206.
,, ,, ,, ,, ,, ,, d'Alton, p. 8.
Ohne Namen. Meckel, *System*, p. 298.
Recti capitis postici. Selenka, p. 99, No. 16.
Grand et petit droit postérieur. Gervais et Alix, p. 14.
Rectus capitis posticus minor. Watson, p. 63.
Splenius capitis. Watson, p. 63."

Note.—The muscle is by no means a small one in the Raven, that is if I am correct in comparing my *rect. cap. post. major* with the above one of Gadow and other authors. A comparison of the synonyms of the *recti* muscles throughout the class *Aves* is sufficient to convince anyone of the fact that they still stand in need of careful diagnosis; and further comparative research in representatives of divers groups of birds is a thing much to be desired, in so far as their myology goes.

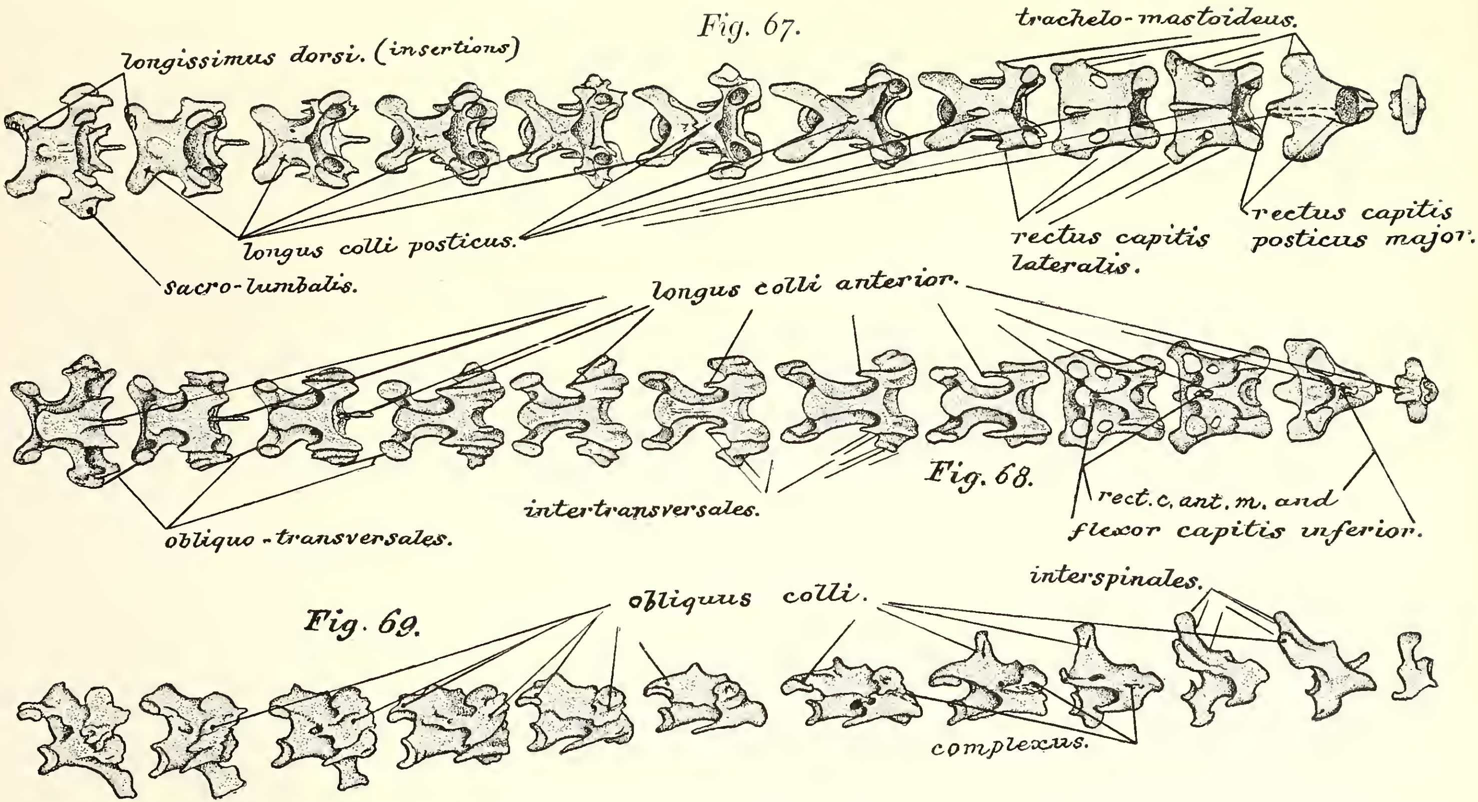

FIG. 67.—The first twelve vertebræ of the column in the neck of a Raven, seen upon dorsal view. FIG. 68.—The same bones seen from beneath.
FIG. 69.—The same from a direct lateral aspect. Drawn life-size, by the author, from his own dissections, and designed to show the origin and insertion of the principal muscles of the region.

side, a powerfully developed muscle, arising, somewhat tendinous, in the median line, upon the anterior aspect of the second cervical vertebra, all the way from the summit of its neural spine to the midpoint of the supero-anterior border of its neural canal. The strong bundle of carneous fibres forming the muscle diverge as they proceed to the occiput from this linear origin, and are inserted upon a crescentic area at the back of the skull. This insertion is within the occipital line, being convex outwards, and situated well towards the mastoidal aspect of the cranium (Fig. 4).

Evidently the united action of these muscles will tend to extend the head upon the neck, and either of them acting independently will tend to pull the head towards that side to which the contracting muscle belongs.

127. *The biventer cervicis* [1] of Wiedemann is an exceedingly interesting muscle, or rather pair of muscles, though they are well separated from each other. Upon looking at the back of the neck of a Raven from

[1] "M. BIVENTER CERVICIS.

Secundum par colli. Aldrovandi.
Digastricus. Steno.
Dünner Halsmuskel. Merrem.
Biventer cervicis. Wiedemann, p. 75.
,, ,, Tiedemann, § 203.
,, ,, d'Alton (Zweibäuchiger Nackenmuskel), p. 8, No. 2.
,, ,, Gurlt, p. 17.
,, ,, Selenka, p. 95, No. 5.
,, ,, Watson, p. 61.
,, ,, Meckel, *System*, p. 295, No. 1.
Digastrique du cou. Cuvier.
Longus colli posticus (pt.). Owen.
Long postérieur du cou (*faisceau occipital*). Gervais et Alix, p. 14.
Faisceau interne ou digastrique du long interépineux cervical. Alix, p. 379." (Gadow in Bronn's *Klassen*, *loc. cit.*, p. 107.)

which the integuments have been removed, we notice at about its middle a deep, longitudinal cleft, which becomes shallower as it approaches its ends, and finally flush with the general muscular surface of the neck. The lateral borders of this cleft, at their middles, show, beneath the enveloping and thin fascia, each a longitudinal tendon. These are the mid-tendons of the muscles we have now under consideration.

A *biventer cervicis* arises by a slight tendon from the side of the neural spine of the first dorsal vertebra, and from the neighbouring tendon of the *longus colli posticus* muscle. This flattened tendon passes directly up the back of the neck, closely applied against the last-named muscle.

At the end of rather more than two centimetres it terminates in a flat spindle-shaped muscle, the tendon being again resumed from the anterior end of the same. This latter division of the tendon is that portion which bounds the cleft above described, passing which, once more a flat muscle is developed, which overlies the *longus colli posticus* anteriorly, and terminates by being inserted into the occiput, to the outer side of the occipital prominence, and between the inner extremities of the insertions of the *complexus* and *rectus capitis posticus major* (Fig. 4).

In speaking of this muscle in the Apteryx, Owen says : "A slender fasciculus is detached from the mesial and dorsal margin of the *longus colli posticus*, near the base of the neck, which soon terminates in a long round tendon ; this tendon is traced down by short aponeurotic fibres to the spine of the fifth, fourth, third, and second cervical vertebræ inclusive, immediately beyond which it again becomes fleshy, and expands to be inserted into the occipital ridge ;

this portion is the *digastrique* or *biventer capitis* of Cuvier" (*Anat. of Verts.*, vol. ii. p. 88).

These muscles are also present in the Raptorial birds.

128. *The longus colli posticus* is, on either side, a complicated muscle extending the entire length of the back of the neck, from its base at the anterior portion of the dorsum, to its final insertion upon the *vertebra dentata*.

It arises by a thin sheet of tendon from the marginal edges of the summits of the neural spines of the first two leading dorsal vertebræ. This sheet of tendon appears to be in continuation with the tendon of origin of the *longissimus dorsi*, and like it is irregularly split up into narrow little ribbonlets of varying width, and some five or six in number.

This tendinous origin of the *longus colli posticus* soon becomes muscular as it advances up the neck, and as a long, somewhat narrow, flattened muscle it extends the entire length of this part, to become finally inserted into the transverse process of the axis vertebra.

From the under side of this muscle, at its dorsal extremity, it throws down certain fleshy fasciculi. The first or most posterior one of these blends with the muscular portion of the *longissimus dorsi*. Then follow six well-defined slips, each flattened from before backwards, and each becoming narrower as we proceed towards the head. The most anterior fasciculus of this series is the longest, and they progressively become shorter as we proceed towards the thorax.

Regarding the neck from a lateral view, and lifting up the *longus colli posticus*, we observe that these descending fasciculi pass obliquely from the under side of the muscle forwards to their insertions. The first of these latter is the postzygapophysis of that cervical vertebra which supports the shorter pair of

free cervical ribs. The remaining five fasciculi makes similar insertions, but become more and more intimately blended with the *obliquus colli* muscles of the same side, and which make similar insertions.

Now, where these fasciculi terminate in the middle of the neck, we find another series commencing. Calling the one at the middle of the neck the first of this new set, we find it to be a long slender slip which arises, tendinous, from the neural spine of the *seventh* cervical vertebra, and extending obliquely forwards (just the reverse of the last series) it merges with the fibres of the under side of the *longus colli posticus* proper. The next in order of this series of fasciculi is shorter and thicker, and thus they proceed until the last or sixth one, coming from the neural spine of the axis vertebra, blends very intimately with the inner margin of the *longus colli posticus* at its proper insertion. This last fasciculus is the shortest and thickest of this series.

Professor Garrod gave an excellent figure (*P.Z.S.*, Plate xxvi.) of the very interesting arrangement of the *longus colli posticus* in the *Plotus anhinga*, and after describing its peculiarities as they are found in that bird, he says, in conclusion, that "It is nearly always the case in avian anatomy that the inner fibres of the cervical portion of the *longus colli posticus* muscle become differentiated to form the *digastrique du cou* of Cuvier, better known to us as the *biventer cervicis*, a muscle one peculiarly interesting modification of which, in the genus *Ceryle* among the Alcedinidæ, has been described and figured by Dr. Cunningham in the Society's *Proceedings* (1870, p. 280). This, by the way I may mention, I have had the opportunity of fully verifying. Meckel, in his *General Treatise on Comparative*

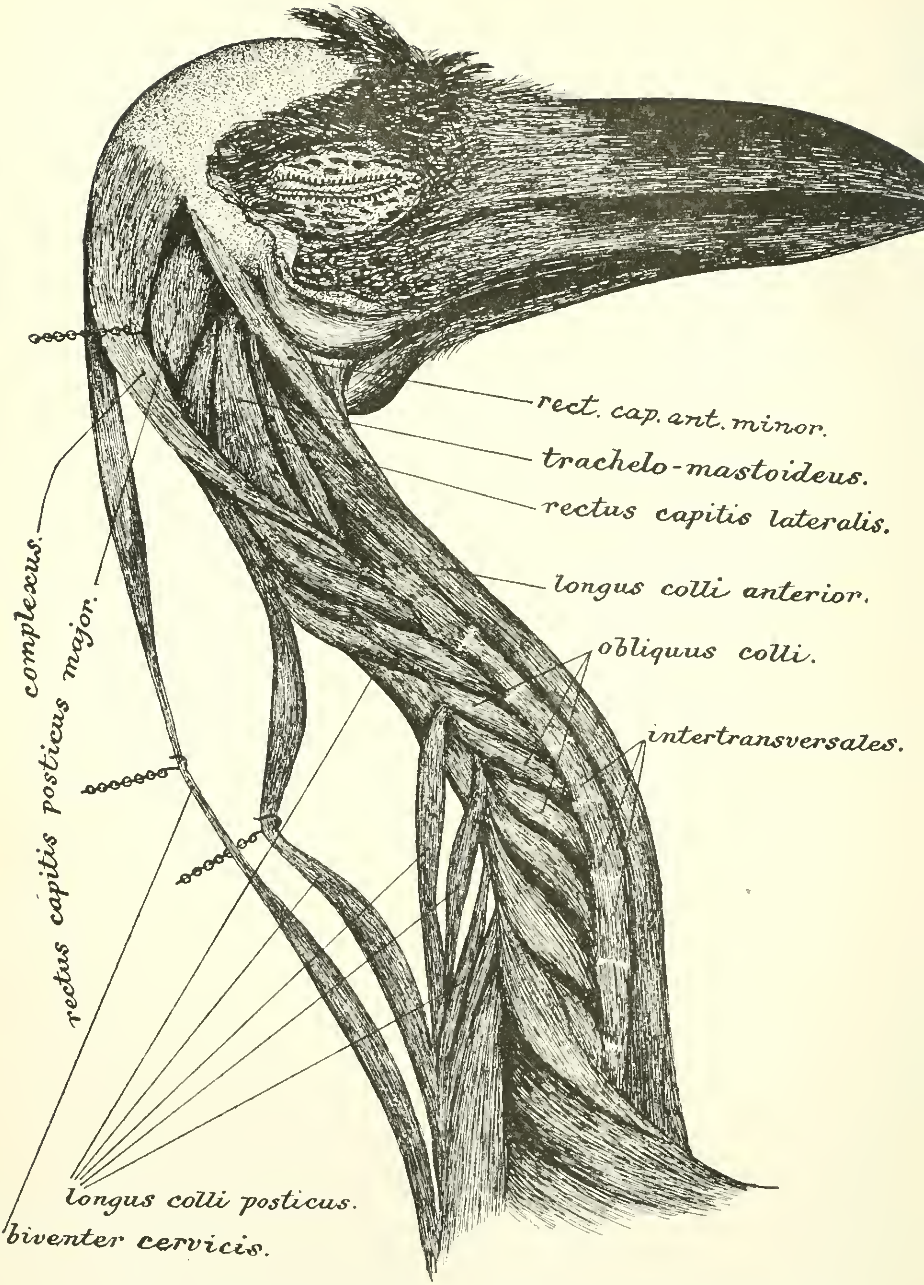

Fig. 70.—Right lateral view, life-size, of the head and neck of a Raven, dissected and drawn by the author. Designed to show the superficial muscles of the region. Those at the back of the neck are lifted from their positions; while the *biventer cervicis* and *complexus* are widely separated in order to show the muscles lying beneath them.

Anatomy, tells us that he found it at its minimum of development in the Gallinæ, the Goose, and the Cormorant. In a specimen of *Sula fusca*, as well as in *Phalacrocorax carbo*, it is present, but extremely small, I find. It is entirely absent in *Plotus anhinga*, the *longus colli posterior* (*cervicalis ascendens*, Meckel) entirely ceasing at the lower margin of the axis vertebra, in the tendon above described."

The *longus colli posticus* in the *Apteryx*, as described by Professor Owen, differs in the number of fasciculi of its accessory series, and other minor details, while in the main it practically agrees with the muscle as I have here described it for the Raven. I regret to say that Meckel's work is not at present at hand, and consequently I am debarred from making comparisons that would greatly enhance the value of my work.[1]

[1] I here present Owen's description of this muscle in the *Apteryx*, as it may be of interest to compare it. He says:—"The *longus colli posticus* is most internal or medial of the superficial muscles of the dorsal aspect of the thoracic and cervical regions. At its posterior part it seems to be a continuation of the *longissimus dorsi;* its medial and anterior part offers a strong analogy with the *biventer cervicis;* it is the homologue of the first, or medio-dorsal series of the oblique fibres of the muscular system in fishes. It commences by long and slender, but strong, subcompressed tendons from the spines of the sixth, fifth, and fourth dorsal vertebræ: these tendons gradually expand as they proceed forward and downward, and send off from their under surface muscular fibres which continue in the same course, and begin to be grouped into distinct fasciculi at the base of the neck; the first of these bundles joins a fasciculus of the *longissimus dorsi*, which is inserted into the anapophysis of the thirteenth cervical vertebra; the succeeding fasciculi derive their origins from a broad and strong aponeurotic sheet attached to the spines of the fourth, third, and second dorsal vertebræ: the second to the eighth fasciculi inclusive are compressed, broad, and fleshy, and are inserted in the strong round tendons de-

129. *The sacro-lumbalis* muscle in the Raven is but moderately developed, and quite intimately blended with the *longissimus dorsi* throughout its entire extent.

It is only in the highly organized vertebrates (*Homo*) that we find a great complexity of the musculature of the dorsal region. Mivart, alluding to this matter, says that "the *erector spinæ* presents in man a degree of differentiation not generally found in animals below his class. Thus in the Iguana and Chameleon it is but divisible into the longitudinal parts answering respect-

scribed in the preceding muscle [*obliquus obliqui*], and attached to the zygapophysis of the twelfth to the sixth cervical vertebræ inclusive: the ninth fasciculus, which forms the main anterior continuation of the *longus colli posticus*, is longer than the rest, and receives, as it advances, accessory fibres from the spinous processes of the seventh to the third cervical vertebræ inclusive, and is inserted, partly fleshy, partly by a strong tendon, into the side of the broad spine of the *vertebra dentata*" (*Anat. of Verts.*, vol. ii. pp. 87–88).

It is three years since this footnote was written, and at this date I can add to it the synonymy of the *longus colli posticus* as compiled for us by Gadow, who designates the muscle as his "System des M. spinalis." It is as follows:—

"7. System des M. spinalis.

Spinalis dorsi. Gurlt, p. 18.
" " Selenka, p. 96, No. 6.
Long postérieur du cou (pt.). Gervais et Alix, p. 14.
Longissimus dorsi (pt.). Watson, p. 56.

"Theil III.

Strecker des Trägers. Wiedemann, p. 76.
M. extensor atlantis. Tiedemann, § 212.
Halsdornmuskel. Meckel, *System*, p. 294, No. 5.
Longus colli posticus (pt.). Selenka, p. 95, No. 4.
Longus colli posterior. Garrod, *Proc. Zool. Soc.*, 1876, p. 338.
Extensor magnus colli (pt.); *splenius colli.* Watson, p. 57." (Bronn's *Klassen des Thier-Reichs*, vi. Bd., p. 110).

ively to the *longissimus dorsi* and *sacro-lumbalis*, and continuing, with the intervention of certain neck muscles, from the cranium to the end of the dorsum of the tail. But a great simplicity still may exist, as in Tailed Batrachians (e.g. *Menopoma* and *Menobranchus*), where, without the intervention of any such neck muscles, a simple, or more or less tendinously intersected muscular mass extends from the skull directly to the end of the dorsum of the tail. This dorsal muscle may be reduced to a mere rudiment, as in *Emys*, where it runs between the transverse and neural processes and the carapace" (*Elem. Anat.*, pp. 322, 323).

Among the group of muscles we are now examining, the deep layer of muscles of the back in the Raven, the *sacro-lumbalis* forms the outer portion of that close-fitting, tendo-muscular sheet seen extending between the anterior margin of the ilium to the root of the neck, and is to be only with difficulty differentiated from the *longissimus dorsi*, which is to be found between it and the dorsal neural spines.

It arises,[1] quite tendinous, from the anterior margin

[1] The system of musculature of the dorsal region in birds, Professor Gadow defines as the "I. DORSO-SPINALE MUSKELN," and proposes to divide this "System des M. sacro-spinalis" into four parts, viz. —1. M. ILIOCOSTALIS; 2. M. LONGISSIMUS DORSI; 3. M. CERVICALIS ASCENDENS; and 4. M. TRANSVERSO-OBLIQUUS. Of these, the first represents the muscle we now have under consideration, or the SACRO-LUMBALIS, and for it Gadow sees the following synonymy, viz. :—

"1. M. ILIOCOSTALIS.

Costo-cervical (pt.). Vicq d'Azyr, 1772, p. 580, No. 2.
Aeusserer Rückgrats-Strecker. Tiedemann, § 217.
Der Rückenmuskel. Merrem.
Opisthotenar (Aeusserer Bauch). Meckel, *System*, p. 291, No. 1.
Sacro-lumbalis. Owen; Gurlt, p. 18

of the ilium; from the angles of the last two vertebral ribs; and by tendinous slips from the outer ends of the transverse processes of the last three dorsal vertebræ. These last tendinous fasciculi spread out upon, and merge with, the under side of the muscle, and probably represent, as Owen says, the *musculi accessorii ad sacro-lumbalem.* To be seen, the free and outer margin of the muscle under discussion must be elevated.

The *sacro-lumbalis* is inserted by a few fleshy fibres into the angle of the first dorsal rib, and in muscular subjects sometimes by a few additional fibres to corresponding points upon the free cervical ribs; while its main insertion is by a strong semi-tendinous insertion into the outer extremity of the diapophysis of the twelfth cervical vertebra.

As we might have expected, Sir Richard Owen found the insertion of this muscle considerably more extensive than this in the *Apteryx*, and this eminent anatomist seemed to see in the final insertions of the *sacro-lumbalis* in that bird, the representatives of the *cervicalis descendens* and *ascendens* as they have been described for man.

130. *The longissimus dorsi*[1] has already been alluded

Sacro-lumbalis. Selenka, p. 93, No. 1.
,, ,, Gervais et Alix, p. 13.
,, ,, Watson, p. 55."

Note.—For Gadow's descriptions of his divisions of the spinal system of muscles, see Bronn's *Klassen des Thier-Reichs*, vi. Bd., pp. 105–107.

[1] See footnotes under the *sacro-lumbalis* muscle of the present work (No. 129), and the following synonymy will be made clear:—

"2. M. LONGISSIMUS DORSI.

Costo-cervical (pt.). Vicq d'Azyr.
Innerer Rückgrats-Strecker (*sacro-lumbalis*). Tiedemann, § 217.

to, and its relative position defined in describing the last muscle. In Figs 66 and 67, I find that I can indicate only the principal origins and insertions of these less important muscles of the back, as an injury would be done the drawings, and its general clearness interfered with, if all the smaller origins and insertions were given, together with the necessary lines to indicate them.

The present muscle has quite a complicated origin, though its insertion is rather simple. It arises from the inner moiety of the anterior margin of the ilium, and from the various surfaces afforded it by the walls of the corresponding "ilio-neural canal," or that channel existing between the ilium and the crista of the sacrum in front. In some specimens I have seen the posterior tendinous ends of the *longissimus dorsi* extend beyond the hinder opening of this channel, and in some cases almost reach the superior caudal muscles. Of course, in Reptiles, the muscle is continuous the entire length of the back and tail, to the very tip of the latter.

In our subject the *longissimus dorsi* also arises by a series of short and distinct tendons alternately from the anterior and posterior extremities of the summits of the neural spines of all the dorsal vertebræ. It will be remembered that the free margins of these neural spines above are bifurcated behind and pointed in front. Now the tendons of this series attached to the points in front extend forwards and merge into the muscle, and are tendons of insertion, while those

Opisthotenar (Innerer Bauch). Meckel, *System*, p. 291, No. 1.
Longissimus dorsi. Gurlt, p. 18; Owen.
,, ,, Selenka, p. 94, No. 2.
,, ,, Watson, p. 56.
Long du dos. Gervais et Alix, p. 13."

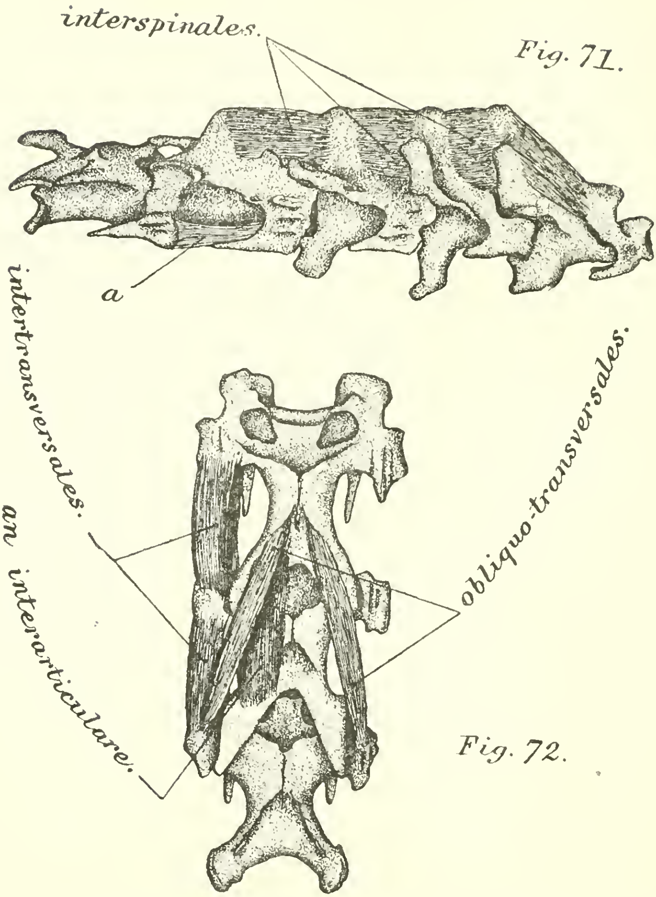

FIG. 71.—The upper figure is a right lateral view of the first six cervical vertebræ, including the axis and atlas (size, $\times 1\frac{1}{2}$). *a* points to that portion of the *intertransversalis* muscle which passes between the *parapophyses* of the fifth and sixth cervicals. (See description in text.)

FIG. 72.—Dorsal view of the sixth, seventh, and eighth cervical vertebræ ($\times 2$), showing representations of three other sets of deep muscles of this region—the *intertransversales*, the *interarticulares*, and *obliquo-transversales*. Drawn by the author, from his dissections of the Raven.

coming off from the tip of the bifurcation behind take just the opposite course, and are additional tendons of origin. So when we pull the muscle away from the

sides of the dorsal neural crests, a system of Xs are seen to be formed by these little tendons crossing each other.

The *longissimus dorsi* in the Raven also arises, somewhat fleshy, from the diapophyses of the dorsal vertebræ, and from the fascia between it and the *sacro-lumbalis,* and also by a tendinous sheet continuous with the origin of the *longus colli posticus* from the free surfaces of the crests of the neural spines of the last three dorsal vertebræ.

It will be seen from all this, that the present muscle, on either side, fills in the "ilio-neural canal" of the pelvis; the open angle formed by the neural spines and diapophyses of the dorsal vertebræ; and is bounded externally principally by the *sacro-lumbalis* muscle.

Now the *longissimus dorsi* is further inserted by four fasciculi, the anterior one being strong and tendinous, into the free hinder margins of the oblique processes of the eleventh, twelfth, thirteenth, and fourteenth vertebræ, respectively.

These insertions are so disposed that the *obliquus colli,* or the series of muscles so called, seem to constitute the harmonious continuation of them up the side of the neck; while above, the *longissimus dorsi* is apparently so continued up the back of the neck by the *longus colli posticus.*

131. *The obliquus colli* [1] consists of a series of

[1] Turning to the *sacro-lumbalis* (No. 129) of the present work, and consulting the footnotes there given, the following synonymy is further illustrative :—

"4. M. TRANSVERSO-OBLIQUUS.

Extensor parvus colli. Wiedemann, p. 77; Tiedemann, § 214; Watson, p. 58.

Quermuskel des Nackens. Meckel, *System,* p. 294, No. 5.

seven oblique fasciculi of muscles seen at the side of the neck. The first or posterior one of these is the one which links the continuation of the system commenced by the *longus colli posticus*, the *longissimus dorsi*, and the *sacro-lumbalis*, and which is continued by the remaining fasciculi of the present muscle.

This first or posterior representation of this complicated series, as I say, arises from the diapophysis of the eleventh cervical vertebra, winds obliquely over the tenth vertebra to become inserted into the hinder margin of the postzygapophysis of the ninth vertebra,

Obliquus colli. Owen.

Obliquo-transversales. Selenka, p. 97, No. 11."

In order to make the spinal system of muscles in birds complete as worked out by Gadow, we must yet quote his third part, which is as follows :—

"3. M. CERVICALIS ASCENDENS.

Long extenseur du cou (pt.). Vicq d'Azyr.

Grosser Halsstrecker (pt.). Tiedemann, § 213 ; Wiedemann, p. 76.

Longus colli posticus (pt.). Owen ; Selenka, p. 95, No. 4.

Aufsteigender Nackenmuskel (pt.). Meckel, *System*, p. 293, No. 1.

Cervicalis descendens. Gurlt, p. 18.

Long postérieur du cou. Gervais et Alix, p. 14.

Extensor magnus colli (pt.). Watson, p. 57."

Note.—In consulting this synonymy, it must be compared with the account of the *longus colli posticus* muscle of the present work, of which Owen considered the above muscle to be but a part :—

"3. M. CERVICALIS ASCENDENS.

"Der laterale Theil (*Cervicalis ascendens*). Seine oberflächlichen Fasern sind directe Fortsetzungen des *M. iliocostalis*, oder der seitlichen Theile des *M. longissimus dorsi*. Er entspringt in seinem hintersten (caudalwärts) Theile von den Rippen, hauptsächlich aber von der Oberfläche der Querfortsätze, weiter kopfwärts aber von den Enden oder Spitzen derselben. In der ganzen Länge des Halses ist der *Cervicalis ascendens* mit der unteren seitlichen Halsmuskulatur verwachsen, die an der unteren Kante der Querfortsätze und an den Halsrippen entspringt." (Gadow, *loc. cit.*, p. 107.)

being joined in its passage by the third descending fasciculus from the *longus colli posticus* (the *fasciculi obliqui* of the *longus colli posticus*, or rather the third one of the series as so described by Owen?).

Now, the next fasciculus of the muscle we have under consideration arises from the transverse process of the *tenth* cervical vertebra, winds about, parallel with the last, to skip the ninth, and be inserted into the hinder margin of the postzygapophysis of the eighth vertebra; it also being joined by the next fasciculus in order descending from the *longus colli posticus*.

The next three fasciculi arise in a similar way, but in addition to being attached to the postzygapophyses they continue forwards to make an insertion also upon the neural spines of the alternate vertebræ in turn, being inserted in fact with the anterior set of descending fasciculi from the *longus colli posticus*.

The insertion of the last two slips of the *obliquus colli* again differ. The most posterior of these two arises from the transverse process of the sixth vertebra, and passing less obliquely up the neck, becomes inserted into the extremity of the diapophysis of the fourth vertebra, by a strong tendon; the outermost carneous fibres of the fasciculus, still continuing towards the head, make another tendinous attachment to the outer extremity of the transverse process of the third vertebra.

Now the last or most anterior fasciculus of this series arises from the transverse process of the fifth vertebra, and passing under and parallel with the last, is inserted with its leading tendon into the extremity of the diapophysis of the third vertebra. This completes one of the most complicated systems of muscles that

I have any knowledge of, and is scarcely excelled by the so-called, and famous "fifth layer" that adorns the dorsal region of *Homo*.

Owen found the *obliquus colli* fully developed in the *Apteryx*, and says of it that "this series of muscles seems to represent the *transversalis colli*, which is the anterior continuation of the *longissimus dorsi* in Mammalia, but it differs in being inserted into the oblique, instead of the transverse processes. In the direction of their fibres these fasciculi resemble the *semispinalis colli*, but they are inserted into the oblique processes instead of the spines of the vertebræ" (*Anat. of Verts.*, vol. ii. p. 86). It will be noticed that we found in the middle of the series in our present subject that they do pass to the neural spines.[1]

[1] In his dissections of the *Apteryx*, Professor Owen also made out in the dorsal region of the back the *spinalis dorsi*, the *multifidus spinæ*, and the *obliquo-spinales*. These muscles in the Raven cannot be satisfactorily differentiated—if indeed they are present at all—or even their barest rudiments. Upon a number of specimens I have taken great pains to endeavour to isolate them, but was after all forced to the conclusion that they do not exist in so high a type as *Corvus*. I quote in full here from the second volume of the *Anatomy of Vertebrates* what Professor Owen says of them as they occur in the *Apteryx*, so we may have the data for comparison. According to this authority, the *spinalis dorsi* is brought into view by the removal of the dorsal portion of the *longus colli posticus* and the *longissimus dorsi*.

"It arises by two long, narrow, flattened tendons from the spines of the eighth and seventh dorsal vertebræ: these pass obliquely downward and forward, expanding as they proceed, and terminate in two fasciculi of muscular fibres: the posterior bundle passes forward beneath the anterior one, and inclining inward and upward, divides into two portions, inserted by long tendons into the spines of the second and first dorsal vertebræ; it then sends a few fibres forward to join the outer and anterior fasciculus, which is partly inserted by a slender tendon into the

132. *The longus colli anterior* is that complicated muscular mass which is found running the entire length of the anterior aspect of the neck, superficially. To be properly studied it must first be carefully un-

spine of the last cervical vertebra: the rest of the fibres of the second fasciculus join the portion of the *longissimus dorsi* which is implanted into the posterior oblique process of the last cervical vertebra. The three inserted tendons of the *spinalis dorsi* are also the medium of attachment of fibres continued from the *multifidus spinæ*, beneath them.

"The series of muscles called *multifidus spinæ* arises by fleshy fibres from the diapophyses of the five last dorsal vertebræ, which pass upward, forward, and inward, to be inserted by four flat tendons into the spines of the seventh to the third dorsal vertebræ inclusive, and by the tendons of the *spinalis dorsi* into the two anterior dorsal spines.

"*Obliquo-spinales.* The removal of the *multifidus spinæ* brings into view a series of long, narrow, flat tendons, coming off from the spines of all the dorsal vertebræ, and slightly expanding as they proceed forwards and obliquely downwards and outwards; they become fleshy half-way from their origin, and are inserted into the posterior oblique and transverse processes of the six anterior dorsal vertebræ, and into the posterior oblique processes of the three last cervical vertebræ" (pp. 88, 89).

Although these muscles are of no particular importance as compared with far more constant elements of the muscular system, and still less so with such muscles as can be effectively utilized in classification, still their study and investigation affords not a little material of interest when we come to search for them as facts simply to illustrate our comparative researches.

To this end they may be advantageously compared with the dorsal muscles of *Echidna* and *Ornithorhynchus* and the lower forms of birds.

For still further information upon this point see Gadow's ("9. M. MULTIFIDUS + SEMISPINALIS") account in Bronn's *Klassen des Thier-Reichs*, vi. Band, pp. 113, 114; also Selenka in the same work (*M. multifidus spinæ*), p. 96, No. 7; likewise the works of Gurlt (p. 18), and Meckel's *System*, p. 292, No. 2. The subject demands more extended research and comparison.

ravelled from one end to the other, and its various origins and insertions neatly cleaned down to the very bone.

We then find the muscle composed of three distinct portions, as in some of the Mammalia, viz. a *vertical portion*, and a *superior* and an *inferior oblique* portion. Besides these, there are certain *accessory fasciculi* to be examined.

The vertical portion of the *longus colli* is the major division of the muscle. It arises, largely fleshy, from the hypapophyses of the tenth to the fifteenth vertebræ inclusive, and extends the entire length of the neck to be inserted by a strong tendon into the inferior tubercle of the atlas, alongside of the similar tendon coming from the fellow of the opposite side, with which in this locality it is intimately blended,—while attached to the same tubercle to its outer side we find the tendon of the superior oblique portion. Now from the under side of this division of the *longus colli* we find a system of tendons given off, which become longer and longer as they reach up the column, and in turn become attached to the apices of each and all of the parapophyses of the cervical vertebræ to include the *tenth*, and exclude the first three. It will be seen that the hypapophyses of the dorsal vertebræ trifurcate, and the part of the *longus colli* which arises from the lateral processes thus formed, is more or less distinct, especially posteriorly, but scarcely enough so as to warrant its being described as a separate portion.

Mesially, at the anterior division of the neck, the *longus colli anterior*, in our subject, also throws off tendons as it passes the fourth, third, and second cervical vertebræ, which respectively become attached to the hypapophyses of these vertebræ. Beneath these

tendons the carneous portion of the muscle is more or less attached to the centra of the vertebræ in question, which several attachments correspond to the *accessory fasciculi* down the remainder of the neck to at last distinctly include the eighth vertebra. Each of these fasciculi arise from the fore part of the pleurapophysis of a vertebra, and pass obliquely upwards to become attached to the under side of that tendon of the *longus colli* which is inserted into the apex of the parapophysis of the vertebra next beyond.

This system of *accessory fasciculi* of the *longus colli anterior* can only be satisfactorily examined after the muscle has been forcibly pulled away from the vertebral column, catching ahold of it near its middle.

The *superior oblique* portion of the muscle is quite distinct, and arises from the diapophyses of the fifth, fourth, and third vertebræ, and passing upwards becomes tendinous, and is inserted, as already stated, into the inferior tubercle of the atlas, to the outer side of the tendon of the vertical portion.

The *inferior oblique* portion is also distinct, but must be regarded more in the light of a specially differentiated fasciculus from the vertical portion.

It arises from the transverse processes of the sixth, fifth, and fourth vertebræ (mesiad to the preceding portion on the fifth and fourth), passes upwards, and is inserted by a delicate tendon into the apex of the parapophysis of the third vertebra.

In the *Proceedings of the Zoological Society of London* (1876, pl. xxvi.), Garrod gives an excellent figure showing the interesting peculiarities of the *longus colli* in *Plotus*, and Sir Richard Owen says of it in the *Apteryx* that "this large and long muscle, which appears simple when first exposed, is found to

consist, when unravelled by further dissection, of a series of closely succeeding, long, narrow fasciculi, arising from the hypapophyses of the sixth dorsal to the first dorsal, and from the ten posterior cervical vertebræ; and sending narrow tendons, which increase in length as they are given off more anteriorly, obliquely forward and outward, to be inserted into the pleurapophyses of all the cervical vertebræ save the first two: the highest or foremost tendon is attached to the tubercle at the under part of the ring of the atlas; but this tendon is also the medium of insertion of five small fasciculi of muscular fibres arising from the diapophyses of the sixth, fifth, fourth; third, and second cervical vertebræ" (*Anat. of Verts.*, vol. ii. p. 90).

It will be seen here that this eminent anatomist made no distinction of the *superior oblique* and *inferior oblique* portions; and that the *accessory fasciculi* apparently *all* go to the same tendon for their insertion, whereas in the Raven they pass to the several tendons in turn, as they are thrown off from the main muscle to become attached to the apices of the spine-like parapophyses. It will be seen, too, that Professor Owen says in the *Apteryx* that the tendons of this muscle are attached to the pleurapophyses instead of the parapophyses, as they are in the Raven, and as Garrod figures them in *Plotus*.[1]

[1] Gadow's account of the *longus colli anticus* is very full and clear, and of it he gives the following synonyms:—

"14. M. LONGUS COLLI ANTICUS.

Long fléchisseur du cou. Vicq d'Azyr, 1773, p. 582, No. 4.
Langer Halsbeuger. Wiedemann, p. 77.
,, ,, Tiedemann, p. 291, No. 9.
Langer Halsmuskel. Meckel, p. 295, No. 1.
Longus colli. Gurlt, p. 19.

133. *The rectus capitis lateralis* is a well-developed muscle in the present subject. It arises somewhat tendinous from the diapophyses of the fifth, fourth, and third cervical vertebræ; and, passing obliquely upwards in front of the spinal column, the fibres converge to form a strong, sub-compressed tendon, which is inserted into the inner tubercle on the basal ridge of the basitemporal.

134. *The trachelo-mastoideus*[1] is a powerfully deve-

Longus colli. Owen, *Apteryx*, p. 310.
,, ,, Selenka, p. 100, No. 19.
,, ,, Watson, p. 60.
Long antérieur du cou. Gervais et Alix, p. 15.
Longus colli anterior. Garrod, *P.Z.S.*, 1876, p. 337.
Longus colli externus. Watson, p. 61." (The reader is referred to Bronn's *Klassen des Thier-Reichs*, vi. Band, p. 118.)

[1] No little confusion seems to exist in recognizing and distinguishing these remaining two cervical muscles, *i.e.* the *rectus capitis lateralis* and the present one, the *trachelo-mastoideus*. For my own part, I can show them no clearer, at present, than I have attempted to do in Fig. 70 of this work. Even Gadow seems to have seen the two muscles in his one that he has called the "*longus lateralis cervicis et capitis*," and of which he gives the following account (*loc. cit.*, pp. 116, 117):—

"13. M. LONGUS LATERALIS CERVICIS ET CAPITIS.

Les droits latéraux de la tête. Vicq d'Azyr, 1773, p. 582, No. 6, Cuvier.
Grand transversaire. Cuvier (?).
Seitenbeuger des Kopfes. Wiedemann, p. 75.
Flexor capitis lateralis. Tiedemann, § 208.
Halsdorn-Muskel; Quermuskel des Nackens. Meckel, *System*, p. 294, No. 5.
Trachelo-mastoideus. Meckel (?).
,, ,, Owen, *Apteryx*, p. 285 (?), Selenka, p. 99, No. 15.
Rectus capitis lateralis. Owen, *P.Z.S.*, 1842, p. 22.
,, ,, ,, Selenka, p. 99, No. 18.
,, ,, ,, Watson, p. 63 (pt.).

loped muscle, flattened from side to side, and situated external to, and completely overlapping, the *rectus capitis lateralis.*

It arises, semitendinous, from the diapophyses of the fifth, fourth, third, and second cervical vertebræ, and the fibres rapidly converging as they pass obliquely towards the skull, unite to form a strong and subcompressed tendon, which is inserted into the outer tubercle of the basal ridge of the basitemporal at the base of the cranium.

This muscle apparently exactly agrees with the *trachelo-mastoideus* in the *Apteryx* as described by Owen; except in this latter bird it seems to be inserted a

Basi-transversaire. Gervais et Alix, p. 15.
Longus colli externus. Watson, p. 61.

"Das specielle Verhalten der diesen Muskel zusammensetzenden Bündel ist bei Anser wie folgt. Ein Bündel entspringt von der unteren Hälfte der *Proc. transv.* des 8 Wirbels, verbindet sich dann mit der tieferen Partie des vom 7 Wirbel kommenden Bündels, und inserirt sich am freien Ende der Halsrippen des 7 Wirbels.

"Die vom 7 Wirbel entspringenden Theile gehen zu den Halsrippen des 6 und 5 Wirbels,

die des 6	zu den Halsrippen des	5, 4 und 3 Wirbels,
,, ,, 5	,, ,, ,, ,,	4, 3 ,, 2 ,,
,, ,, 4	,, ,, ,, ,,	3, 2 ,, 1 ,,
,, ,, 3 und 2	,, ,, ,, ,,	1 ,,

und zum hinteren Rande des *Os occipitale* basilare, seitlich neben dem *Condylus.*

"Es treten unter diesen Muskeln jedoch äusserst verschiedene Spaltungen der Ursprünge und Verwachsungen der Insertionen auf, sodass das oben gegebene Verhalten nur als ein schematisches aufzufassen ist. Die Insertionen sind gewöhnlich derart am freien Ende der Halsrippen, dass haupsächlich die oberen Kanten und hinteren Ränder zur Befestigung dienen, während die Seitenränder ziemlich frei bleiben, nur am 2 Wirbel und am Altas rücken die Insertionen entsprechend dem Fehlen des Halsrippen auf die untere Seite der entsprechenden Fortsätze."

little more externally, as the authority quoted states that its insertion is to be found on the paroccipital.

135. *The interspinales* [1] constitute a series of muscles that connect the neural spines of the vertebræ.

[1] In Figs. 71 and 72 I have attempted to clearly portray the system of muscles that may be considered to be strictly *intervertebral* in the cervical region of the Raven, and they probably thus exist in the vast majority of the class. Of the four sets, viz. the *Interspinales*, the *Interarticulares*, the *Obliquo-transversales*, and the *Intertransversales*, Gadow gives good brief accounts, with their several synonymies as he makes them out. All these latter I quote below, with the exception of the *Interarticulares*, for which I fail to find a description by the author in question, unless perchance he includes them in his muscle No. 9, or the *M. multifidus* + *semispinalis*, an account of which I have quoted from him on a former page of the present work (see Bronn's *Klassen des Thier-Reichs*, vi. Band, pp. 113–115):—

"11. M. INTERSPINALES.

Zwischendorn-Muskeln. Meckel, *System*, p. 294, No. 6.
" " Tiedemann, p. 292, No. 12.
Obliquo-spinales. Selenka, p. 97, No. 8.
Interspinales. Owen; Selenka, p. 97, No. 9.
Interarticulares. Selenka, p. 97, No. 9.
Court interépineux. Alix, p. 374."

These I take to represent the *Interspinales* (No. 135), and the next the *Obliquo-transversales* (No. 137), while the last are my *Intertransversales* (No. 138):—

"10. MM. ROTATORES S. OBLIQUO-TRANSVERSALES.

Kleine Zwischenquermuskeln (?). Meckel, *System*, p. 294, No. 7.
Multifidus spinæ. Owen.
Obliquo-transversales. Selenka, p. 97, No. 11.
Muscles articulo- ou épineux-transversaires. Alix, p. 378.

"12. SYSTEM DER MM. INTERTRANSVERSARII.

Zwischen-Quermuskeln. Wiedemann, p. 78.
Vordere und hintere Zwischen-Quermuskeln (*Intertransversarii*). Tiedemann, § 221.
Intertransversaires. Cuvier, vol. i., p. 190.
" Gervais et Alix, p. 14.

They do not occur in the dorsal region of the back, for in this locality their places are usurped by stout and tough ligaments which are quite inelastic. These ligaments are much smaller and cord-like as they extend between the low neural spines in the mid-cervical region. Now it is only between the lofty neural spines of the leading cervical vertebræ, commencing with the second and third to include the fifth and fourth, and between the last few cervicals that we see the true *interspinales*; for passing the thirteenth cervical in ascending the column, we find that these muscles gradually become bilateral, and in the mid-region of the neck, stretch between two vertebræ, and finally become continuous with the anterior descending fasciculi of the *longus colli posticus*.

136. *The interarticulares* represent another deep-seated series of intervertebral muscles. Examining them upon either side, we find that they start as a well-developed muscle extending between the postzygapophysis of the axis to the hinder margin of the ring of the atlas. Then in general throughout the vertebral column, they occur as muscular bands extending from the postzygapophysis of one vertebra to the same processes of the vertebra next beyond. In old and muscular subjects, however, we often see, between the fifth

Intertransversalis cervicis. Meckel, *System*, p. 294, No. 4.
Obliquus colli. Owen, *Apteryx*, p. 282.
Intertransversales anteriores et posteriores cervicis. Selenka, p. 99, No. 17.
Transversus colli. Selenka, p. 94, No. 3.
Intertransverse muscles. Watson, p. 59."

Note.—In this connection see Owen (*Anat. Verts.*, vol. ii., p. 89). I question whether his *obliquus colli* represents the *mm. intertransversarii* of Gadow.—R. W. S.

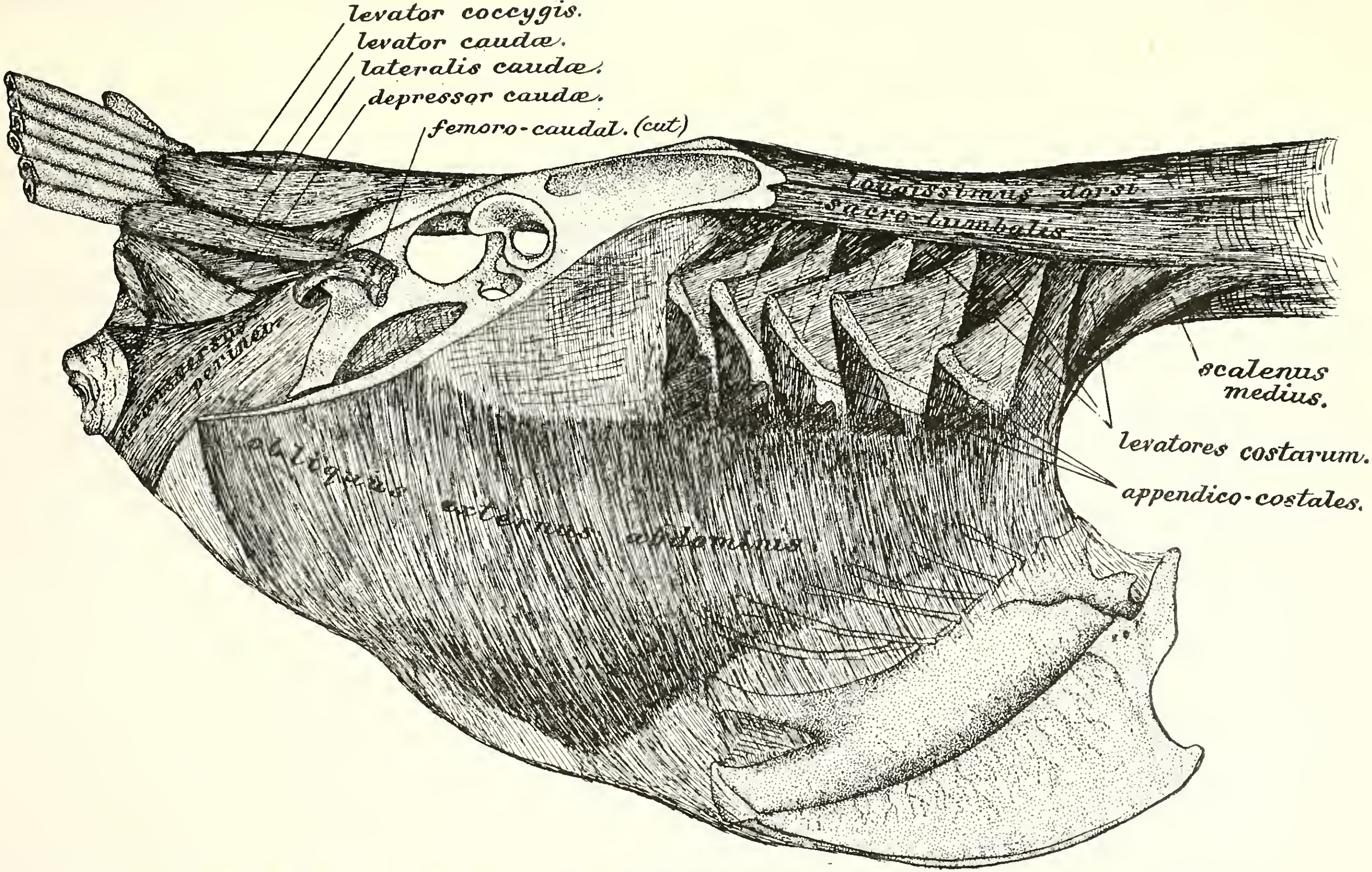

FIG. 73.—Right lateral view, life-size, of the trunk of a Raven, dissected and drawn by the author to show the superficial muscles. The quill-butts of the rectrices have been slightly pulled down in order to show the position of the pygostyle. The triangular aponeurotic appendages attached to the upper sides of the "epipleurals" are well shown.

and fourth, and fourth and third, and third and second, that the fasciculi may extend so as to include two vertebræ.

Owen is of the opinion that this series of muscles in the *Apteryx* are the direct continuation of the *obliquo-spinales* of the back, in that bird.

137. *The obliquo-transversales* are absent in the dorsal region of the back in the *Corvidæ* and our present subject. The *Apteryx* possesses them, where they "appear to be a continuation of the *multifidus spinæ* in the neck" (Owen).

In the Raven they are best studied as they connect the ultimate cervical vertebræ, say the ninth to the twelfth inclusive. Here we find them passing obliquely between the transverse process of one vertebra to the postzygapophysis of the same side of the vertebra next beyond but one.

They lie external to the short, straight *inter-articulares*, being situated more on the sides of the vertebræ, and are best brought into view by dividing the main origin of the *longus colli posticus*, and carefully dissecting it away, as we proceed in the direction of the head.

138. *The intertransversales* are represented by an intimately connected though double series of short, thick muscles, throughout the cervical division of the column, commencing between the third and fourth vertebræ.

The stronger set extend between the transverse processes of the contiguous vertebræ, while the lower or anterior set connect the consecutive parapophyses.

It will be seen upon dissection that this series of muscles also fulfil another function, as they are so arranged that they continue the lateral canals, or rather

afford the proper protection to the vessels and nerves therein contained as they pass from one lateral canal to the next, in the interspaces between the vertebræ, where, of course, no osseous canal affords protection.

139. *The triangularis sterni* [1] is a beautifully developed muscle within the cavity of the thorax.

It arises, somewhat tendinous, from the entire superior margin of the summit of a costal process, and its fibres directed backwards and upwards soon divide into four well-defined digitations; which latter covering the inner surfaces of the leading three costal ribs, become inserted into the first four as high up as their articulations with the vertebral ribs.

It will at once be seen that, the sternum being fixed, a contraction of these muscles will result in drawing down the costal ribs; which, diminishing the cubical contents of the thorax; they thus become a powerful auxiliary to the act of expiration.

The *triangularis sterni* in man, although it has a little different origin, fulfils precisely the same function.

[1] According to Gadow, the following synonyms of the *triangularis sterni* occur in literature (*loc. cit.*, p. 125):—

"18*f.* M. COSTI-STERNALIS.

Der Erheber der Rippenfortsätze. Merrem.

Der innere oder dreieckige. Brustmuskel. (*M. sterno-costalis s. triangularis sterni*) Tiedemann, § 236.

Triangulaire du sternum. Cuvier.

" " " Gervais et Alix, p. 16.

Sterno-costalis. Tiedemann.

Ohne Namen. Meckel, *System*, p. 502.

Triangularis sterni s. sterno-costalis. Magnus, p. 226.

Sterno-costal. Alix, p. 386.

Triangularis sterni. Selenka, p. 104.

" " Watson, p. 68."

140. *The intercostales*[1] are very prettily developed in a Raven. The first or anterior one of the series is the thickest and most evident. It arises from the anterior free margin of the first dorsal rib, commencing as low down as its articulation with the costal rib, and is carried as high up as that point where the dorsal rib gains its greatest width. The fibres pass obliquely upwards and forwards, and are inserted into the posterior margin of the last free rib, which is, of course, the

[1] On pages 121, 122, and 123 of Bronn's *Thier-Reichs* (vi. Band), Gadow devotes a very full account to two sets of "intercostal muscles" in birds, his MM. INTERCOSTALES EXTERNI (18*a*) and his MM. INTERCOSTALES INTERNI (18*b*), while in the same category he places his MM. INTERAPPENDICULARES (18*c*). The synonymy of these "rib-muscles" he presents as follows :—

"*b.* Rippenmuskeln.

"18. SYSTEM DER MM. INTERCOSTALES.

"*Mm. intercostales.*

Muscles intercostaux internes et externes. Vicq d'Azyr, pp. 292–293; Cuvier, p. 324; Gervais et Alix, p. 13.

Mm. intercostales externi et interni, o. innere und äussere Zwischenrippenmuskeln. Tiedemann, § 239; Meckel, *System*, pp. 301 und 302, No. 1–5; *Archiv*, p. 248, No. 1–2; d'Alton, p. 13; Owen.

Mm. intercostales externi et interni, o. innere und äussere Zwischenrippenmuskeln. Magnus, p. 225; Selenka, p. 104, No. 2; Gadow, No. 5; Watson, pp. 69 und 70.

Musculi interappendiculares costarum. Tiedemann.

Accessory external intercostal muscles. Watson, p. 70."

Under his (II.) system of the VENTRI-LATERALE MUSKELN (*a.* Halsregion), Prof. Gadow also describes his MM. INTERTUBERCULARES (No. 17, p. 121): "Ein system von kurzen Muskeln als tiefste Schicht der ventralen Halsmuskulatur. Sie beginnen als selbständige Muskeln von den hinteren Halswirbeln an, während sie weiter rückwärts innig mit den *Mm. intertransversarii anteriores* verwachsen." And for a full account see the work referred to.

one next in front of it. The remaining ribs also have intercostal muscles between them, but their fibres become less and less better developed as we proceed backwards, and in all cases the strongest part of the muscle is just above the articulations with the hæmapophyses; and from these parts the muscles also gradually grow more feeble as we approach the vertebral column, where they are supplemented by the *levatores costarum*. Both an *internal* and *external* set can be made out.

Professor Owen, in his *Anatomy of Vertebrates*, does not especially describe these muscles as occurring in the *Apteryx*.

141. *The scalenus medius* [1] is the most anterior leader of that series of muscles which follow it, called the *levatores costarum*, but is sufficiently conspicuous to deserve a separate name and description. It arises from the diapophysis and pleurapophysis of the eleventh cervical vertebra, and its fibres passing downwards and backwards are inserted upon the entire length of the short free rib which articulates with the twelfth vertebra; and the middle fibres passing over and beyond it are inserted into the anterior free margin of the middle third or more of the second or longer free rib next behind it.

[1] We have the subjoined synonymy of this muscle from Gadow (*loc. cit.*, p. 124):—

"18*e*. M. SCALENUS.

Les muscles qui tiennent la place des scalènes (pt.). Vicq d'Azyr.
M. scalène. Cuvier. (Als den Vögeln fehlend angeführt).
Scalenus (Rippenhalter). Wiedemann, p. 78.
,, (pt.). Tiedemann, § 223; Meckel, *System*, p. 301, No. 1; Magnus, p. 220; Selenka, p. 98; Watson, p. 71.
Scalenus medius. Owen.
Surcostaux (pt.). Gervais et Alix, p. 12.
Musculus teres inter primam et secundam costam. Tiedemann, § 237.
M. teres. Magnus, p. 221."

This muscle is best developed, so far as I am at present aware, in some of the Mammalia.

142. *The levatores costarum*[1] constitute a series of muscles following in sequence the *scalenus medius.* The first or anterior one arises from the extremity of the transverse process of the twelfth vertebra, and its fibres diverging as they pass downwards and backwards become inserted into the anterior free margin of the upper third of the long or posterior free rib, and to the external surface of the same bone, contiguous to this margin.

The succeeding levator muscles of these ribs arise and are inserted in a similar manner; coming off from the ends of the diapophyses of all the dorsal vertebræ, and being directed downwards and backwards are attached to the anterior margins of the ribs next behind them, in any case. They, however, grow gradually more and more feebly developed as we proceed in the direction of the pelvis, and are inserted less and less upon the outer surface of the rib to the border of which they are fast.

143. *The appendico-costales*[2] represent another series of thoracic muscles in birds, and are handsomely developed in the Raven. In each case they arise from

[1] Synonymy in Gadow is as follows (*loc. cit.*, pp. 123, 124):—

"18*d*. Mm. levatores costarum.

Les vertêbraux-costaux.	Vicq d'Azyr.
Die Erheber der Brust.	Merrem.
Levatores costarum.	Tiedemann, § 235.
,, ,,	Owen.
,, ,,	Magnus, p. 222; Selenka, p. 98.
Heber der Rippen.	Meckel, *System*, p. 301, No. 1.
Muscles sur-costaux.	Gervais et Alix, p. 12."

[2] These muscles are alluded to by Sir Richard Owen in his *Anatomy*

the posterior edge of an epipleural appendage, and forming a thin sheet of muscle with its fibres directed downwards and backwards, these latter become attached to the outer surface of the rib next behind the one bearing the appendage from which the muscle takes origin. They are most powerfully developed in the anterior division of the series, growing less strong as we proceed towards the pelvis, and of course, for obvious reasons, the last pair of ribs do not possess them at all.

These epipleural appendages of the ribs are likewise supported, from above, by strong, triangular aponeurotic membranes, which are attached to the anterior edge of the process for its entire length, and

of Vertebrates, vol. ii., p. 92, while under his "Rippenmuskeln" Gadow still describes another, viz. :—

"18*g*. M. QUADRATUS LUMBORUM.

M. quadratus lumborum. Tiedemann, § 241 ; Magnus ; Selenka, p. 105, No. 31.

M. obliquus abdominis internus (pt.). Gadow, No. 4.

"Der bei den meisten Reptilien und Säugethieren gewöhnlich stark entwickelte *Quadratus lumborum* ist bei den Vögeln sehr reducirt. Er ist gewöhnlich ein kleiner, dünner Muskel, der von der Visceralfläche des Hinterrandes der letzten falschen Rippe zum Darmbeinkamme zieht. Er ist als die Fortsetzung der *Intercostales interni* und des *Obliquus abdom. int.* in der lumbo-dorsalen Region aufzufassen. Bisweilen sind durch die Verkümmerung der letzten falschen Rippen zwei kleine *Quadrati lumborum* entstanden, z. B. bei *Rhea.* Der eine mehr kopfwärts gelegene kommt vom Rande des *Tuberculum* und dem proximalen Ende des Körpers der 2 Rippe des 24 Wirbels und inserirt sich fleischig an den gleichen gegenüberliegenden Theilen der nächstfolgenden, fast ganz verkümmerten Rippe und an der Innenfläche des Iliumkammes. Der zweite Muskel entspringt von der Rippe des 25 Wirbels und inserirt in Ermangelung eines Rippenbogens des 26 Wirbels fleischig auf der Innenfläche des Ilium in Höhe des 25 und 26 Wirbels" (*loc. cit.*, p. 126).

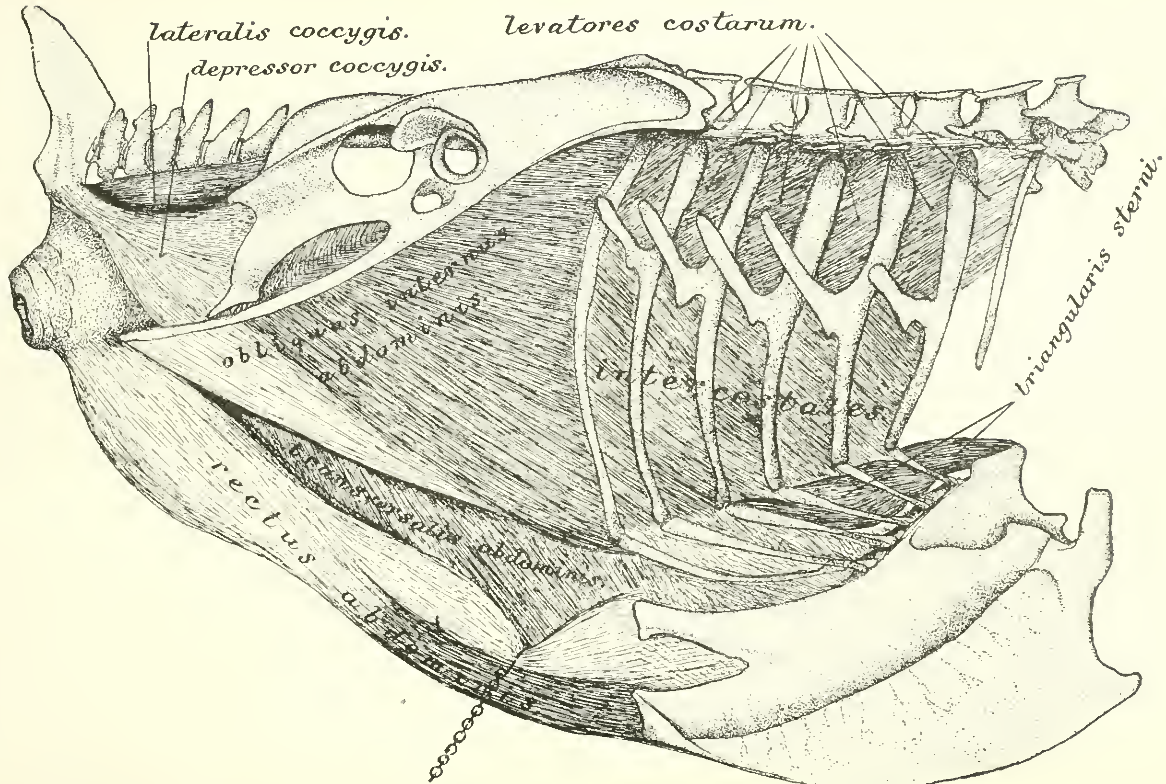

Fig. 74.—Right lateral view, life-size, of the trunk of a Raven, dissected and drawn by the author to show the deep layer of muscles. The dissecting chain pulls down the *rectus abdominis* in order to expose the *transversalis abdominis* lying beneath it

are inserted into the posterior margin of the rib next succeeding and anterior to it in any individual case. With the first pair, these membranes are inserted on the margins of the ribs nearly as high up as the vertebral column, but grow shorter as we near the pelvic extremity of the trunk.

144. *The obliquus externus abdominis*[1] is, as its name implies, the most external of the layer of abdominal muscles, and at the same time it is by far the most extensive.

It arises by a delicate aponeurotic membrane from the sides of all the true dorsal ribs, on a line drawn at about the bases of their epipleural appendages; by an extension of the same membrane from the hinder margin of the last vertebral rib, and the adjoining margins of the pelvis; by fleshy fibres from the entire posterior moiety of the inferior border of the post-pubic element of the pelvis; and, finally, again assuming the aponeurotic character, shades off from the structures lying about the root of the tail, and lower part of the abdomen.

The aponeurotic membrane coming off from all

[1] Most authors have described this muscle under this name, as may be seen by the following synonymy (Gadow, *loc. cit.*, pp. 126, 127):—

"19. M. OBLIQUUS ABDOMINIS EXTERNUS.

M. oblique descendens. Aldrovandi.

M. obliquus exterior. Steno.

Le grand oblique. Vicq d'Azyr, p. 267, No. 1; Cuvier, p. 234; Gervais et Alix, p. 17.

M. oblique descendens. Merrem, p. 151, No. 2.

M. obliquus externus abdominis. Wiedemann, p. 79; Tiedemann, § 229; Owen, *Apteryx*, p. 286; Selenka, p. 102, No. 25; Magnus, p. 230; Gadow, No. 1; Watson, p. 72.

Auesserer schiefer Bauchmuskel. Meckel, *System*, p. 303, No. 1; *Archiv*, p. 249, No. 21."

the ribs, soon gives way at the lower thirds of the ribs to a fleshy layer of transverse muscular fibres which are well developed. These in turn are also more or less attached to the ribs beneath them, along on their line of commencement below the epipleural appendages. The muscular sheet thus formed passes toward the sternum, loosely attached by fascia to the hæmapophyses, overlying and concealing the latter from sight as it does so. Again becoming aponeurotic, it becomes attached to the side of the sternum, and quite firmly so to the under side of the lower part of the *pectoralis major* muscle and the xiphoidal prolongation beneath it. The transverse fibres of this muscular sheet extend down the abdomen, and are continuous with those arising from the edge of the posterior moiety of the post-pubic element of the pelvis already alluded to above. The muscular fibres of the abdominal portion pass somewhat downwards, though nearly transversely, to the median abdominal line, where they terminate in an aponeurosis just before arriving at the linea alba For the upper two-thirds of the abdomen *in the median line*, the aponeurotic fibres decussate, and are quite firmly attached to the skin.

Owen says that in the *Apteryx* "the aponeurosis from the last rib passes to be inserted into a strong ligament extending between the free extremities of the pubic bones, leaving the abdomen, behind the last rib, defended only by the *internal oblique* and *transversalis*." As I have already said, in the Raven the very delicate aponeurosis of the external oblique extends into this recess between the last rib and the pelvis, to become attached in the manner I have already described.

145. *The obliquus internus abdominis*[1] is exposed after we have completely removed the external oblique. It arises aponeurotic from the hinder third of the post-pubic element of the pelvis; and by fleshy fibres from the remaining part of this bone; and occasionally by a few fibres from the iliac border beyond the acetabulum. From this line of origin the fibres of the internal oblique pass longitudinally over the abdomen to the thorax, where they become inserted into the entire posterior margin of the last vertebral rib, and into the pleurapophysial head of the last costal rib; which latter, as we know, is a floating one, and articulates with this last vertebral rib.

The mesial margin of this muscle is free, and does not blend with the *rectus abdominis*, as Professor Owen states that it does in the Kiwi-kiwi, nor do we have the slightest difficulty in the Raven in distinguishing this muscle from the ultimate intercostal muscle, as that eminent authority also found to be the case in his subject.

146. *The rectus abdominis*,[2] on either side, arises

[1] From the same source from which we obtained the synonymy of the external oblique muscle of the abdomen, we have the following (p. 127):—

"20. M. OBLIQUUS ABDOMINIS INTERNUS.

Tertium par musculorum abdominis. Aldrovandi.
M. obliquus interior. Steno.
Le petit oblique. Vicq d'Azyr, p. 267, No. 2; Cuvier, p. 324; Gervais et Alix, p. 16; Alix, p. 387.
M. oblique ascendens. Merrem, p. 151, No. 3.
M. obliquus internus abdominis. Wiedemann, p. 80; Tiedemann, § 230; Owen, *Apteryx*, p. 286; Magnus, p. 231; Selenka, p. 103, No. 26; Gadow, No. 4; Watson, p. 73.
Innerer schiefer Bauchmuskel. Meckel, *System*, p. 303, No. 2."

[2] Following the synonymy of the muscles in Aves as given by

as an aponeurosis from the distal extremity of the post-pubic element of the pelvis, and from that semitendinous ligament which stretches from one post-pubic tip to the other, as far as the linea alba; the *rectus* of the opposite side arising from the remaining half of this ligament.

For half its distance, as the *rectus abdominis* proceeds towards the sternum, the muscle is purely tendinous; this tendon then terminates in nearly a straight transverse line, from which the muscular fibres abruptly commence. These latter then go, longitudinally, directly to the xiphoidal margin of the sternum where they are attached; but beyond the lateral processes of the sternum, though still in line with its sternal attachment, the outer fibres of the *rectus* terminate in a strong, aponeurotic membrane, which, as it passes forwards is gradually lost over the outer surface of the thoracic walls, beneath the external oblique and pectoralis major muscles. The carneous portion of the *rectus abdominis* in this bird fails to exhibit the slightest

Gadow we have the *rectus abdominis* thus compiled for us (*loc. cit.*, p. 130:—

"23. M. RECTUS ABDOMINIS.

Par secundum musculorum abdominis. Aldrovandi.
M. rectus (abdominis). Steno; Merrem, p. 151, No. 1.
,, ,, ,, Wiedemann, p. 80.
,, ,, ,, Tiedemann, § 232.
,, ,, ,, Owen, *Apteryx*, p. 286.
,, ,, ,, Magnus, p. 232.
,, ,, ,, Selenka, p. 103, No. 27.
,, ,, ,, Gadow, No. 3.
,, ,, ,, Watson, p. 74.
Gerader Bauchmuskel. Meckel, *System*, p. 304, No. 4; *Archiv*, p. 249, No. 23.
Le grand droit de l'abdomen. Gervais et Alix, p. 17.
,, ,, ,, ,, ,, Alix, p. 383."

evidences of the *lineæ transversæ*, so familiar to us in many of the Mammalia; and Owen also found them to be present in the Kiwi-kiwi.

147. *The transversalis abdominis*[1] is a very well-defined muscle in the Raven, and is seen to arise, thin and tendinous, from within the entire post-pubic and iliac margins of the pelvis; and to some extent from the inter-pubic ligament. Becoming gradually carneous, its fibres pass across the abdomen, between the peritoneum, the rectus, and the internal oblique, to become inserted over the entire pleural aspect of the last two vertebral ribs, the intercostal muscle between them, and the same surfaces of the hæmapophyses connected below. This part of its attachment is semitendinous. Its abdominal insertion is into the linea alba, which just before reaching, the transversalis becomes completely aponeurotic. This aponeurotic area of the *transversalis abdominis*, when taken in connection with the similar area of the muscle

[1] That patriarch in anatomy, Aldrovandi, gave a striking name to this muscle, as may be seen in the subjoined synonymy from Gadow (*loc. cit.*, p. 128):—

"21. M. TRANSVERSUS ABDOMINIS.

Ultimum par quod transversalium in nobis locum obtinet. Aldrovandi.
Le muscle transverse. Vicq d'Azyr, p. 267; Cuvier, p. 324; Gervais et Alix, p. 74.
M. transversalis. Merrem, p. 151, No. 4.
,, ,, Owen, *Apteryx*, p. 287.
,, ,, Watson, p. 74.
M. transversus abdominis. Wiedemann, p. 80.
,, ,, ,, Tiedemann, § 231.
,, ,, ,, Magnus, p. 232.
,, ,, ,, Selenka, p. 105, No. 30.
,, ,, ,, Gadow, No. 4.
Querer Bauchmuskel. Meckel, *System*, p. 304, No. 3; *Archiv*, p. 249, No. 22."

of the opposite side, is of a spindle-like form, the longitudinal axis of which is represented by the linea alba; and its upper and lower apices being respectively in the mid-point of the xiphoidal margin of the sternum, and the mid-point of the inter-pubic ligament. In a fresh specimen it is white and glistening, and very characteristic.

148. *The diaphragm* (Fig. 75) in the Raven, as in most existing birds, is in a rudimentary condition only, and by no means meets the ends of that muscle as we find it to be the case in Mammalia. It simply consists of a thin, transparent membrane, overlying the peritoneum on the one hand and the pericardium on the other, completely conforming to the forms of the various organs pressing upon it.

Three rudimentary muscles within the thorax, on either side, play upon this attenuated midriff. These arise from the vertebral heads of the second, third, and fourth costal ribs, and their fibres spread out in a fan-like fashion upon the membrane in question. These three muscles gradually increase in size as we pass from before backwards, and are to be seen just above the extremities of the digitations of the *triangularis sterni.*

The best way to examine them is to disarticulate the costal ribs of one side from the sternum; carefully remove the muscular walls of the abdomen; pull the ribs away from the sternum, and pull down the abdominal viscera, upon which the diaphragm will be exposed, and the muscles in question at the sides of the thoracic wall easily examined.

Macgillivray pointed out these muscles for us in his figure showing certain anatomical structures as they exist in *Corvus frugilegus*, and Coues has kindly re-

produced this drawing for us in his *Key to North American Birds*, the second edition (p. 206).

According to Sir Richard Owen, "The *diaphragm* presents more of its mammalian character in the *Apteryx* than in any other known bird. It is perforated by vessels only, in consequence of the non-development of the abdominal air-cells. The origin corresponding to that of the lesser muscles in Mammals is by two strong and distinct, short tendinous pillars from the sides of the body of the last costal vertebra; they are united by a strong tendon or fascia, forming the anterior boundary of the aortic passage. The tendinous pillars may be traced forward for some way in the central aponeurosis, expanding without crossing; they are then lost in that aponeurosis, which is perforated by the gastric arteries and veins, divides anteriorly to give passage to the gullet and the apex of the heart, expands over the anterior part of the thoracic air-cells, and becomes, at its lateral circumference, the point of attachment of muscular fibres arising from the inner surface of the anterior ribs, and forming apparently a continuation of the *transversalis abdominis*" (*Anat. of Verts.*, vol. ii. pp. 91, 92).

Up to the present time I have made no exhaustive examinations of the *diaphragm* in other birds, as I hope to on future occasions. For a number of reasons I look forward to a study of its form in the Vultures and Herons with no little interest.

149. *The levator coccygis*[1] I believe to be the detached caudal extremity of the *longissimus dorsi*

[1] *Seven* muscles, as a rule, seem to control the movements of the tail in most birds, I believe in all ordinary birds. These, as I have already said in the text, I have attempted to give names, or choose names for them from those they have already received at the hands

in birds, which now in their present forms does not extend beyond the postacetabular area of the

of others, such as would designate, not only their actions or functions, but point out likewise their orderly arrangement as it exists in the class for this part of the muscular system.

Gadow has given us quite a full synonymy of some of these muscles, and by its aid no difficulty will be experienced in determining the corresponding muscles of the present work as I have designated them. I give this synonymy below, with a few brief remarks of its author under each heading (Bronn's *Klassen des Thier-Reichs*, vi. Band, pp. 131–135):—

" *d.* Schwanzmuskeln.

" 24. M. LEVATOR COCCYGIS.

Par primum musculorum uropygii. Steno.
Les deux relêveurs du coccyx. Vicq d'Azyr, p. 274, No. 1.
Interépineux sacro-sus-caudien. Cuvier, p. 287, No. 1.
Grosser Schwanzheber. Merrem, p. 161, No. 62, No. 1 u. 2.
Levator coccygis. Wiedemann, p. 82.
,, ,, Tiedemann, § 223.
,, ,, Selenka, p. 100, No. 21.
,, ,, Gadow, No. 6.
,, ,, Watson, p. 65.
Levator caudæ s. spinalis caudæ. Gurlt, p. 19.
Schwanzheber und Zwischendornmuskeln. Meckel, *System*, p. 299; *Archiv*, p. 247, No. 17.
Levator caudæ. Owen, *Apteryx*, p. 286.
Sacro-coccygien supérieur ; transversaire épineux. Gervais et Alix, p. 15.

" Bildet die dorsale Muskulatur des Schwanzes. Er entspringt bei den Ratiten von der *Spina iliaca,* dabei manchmal weiter auf das *Os ilei* und das *Os ischii* übergreifend ; ferner von den Dornfortsätzen der ersten 3–4 Schwanzwirbel."

" Insertion an den Seitenflächen der Dorn- und an den Dorsalflächen der Querfortsätze der folgenden Schwanzwirbel. . . .

" 25. M. DEPRESSOR COCCYGIS.

Abaisseurs du coccyx. Vicq d'Azyr, p. 274.
Niederzieher des Schwanzes. Merrem, p. 162.
Innerer Niederzieher des Steissbeines. Wiedemann, p. 82.

dorsal aspect of the pelvis; but, if we could have examined it in the now extinct avireptilian types, it

Depressor coccygis. Tiedemann, § 224; Selenka, p. 101, No. 24; Gadow, Ratiten, p. 21; Watson, p. 67.

Ohne Namen. Meckel, *System*, p. [?].

Depressor caudæ. Gurlt, p. 19; Owen, *Apteryx*, p. 286.

Coccygien inférieur. Gervais et Alix, p. 16.

"Bildet die Muskulatur auf der Ventralseite der Schwanzwirbel. Entspringt fleischig von den Ventralflächen der Querfortsätze der letzten Sacralwirbel und der meisten folgenden freien Schwanzwirbel. Die einzelnen Bündel, die aber ähnlich wie die des *M. levator coccygis* innig mit einander verwachsen können, inseriren sich an den Ventralflächen der nächstfolgenden Wirbelkörper. . . .

"26 u. 27. Mm. pubi-coccygei.

"A. *M. pubi-coccygeus externus* + *internus.*

Moteurs latéraux du coccyx. Vicq d'Azyr, p. 274, No. 2.

Oberer, grosser, und unterer ausdehnender Schwanzmuskel. Merrem, p. 162, No. 2 u. 5.

Pubo + *ischio-coccygiens.* Cuvier, p. 287, No. 5 u. 6.

Sitzbein Schwanzmuskel. Meckel, *Archiv*, p. 248, No. 18; *System*, § 152.

Adductor caudæ inferior. Owen, *Apteryx*, p. 286.

Adductor caudæ superior et inferior. Selenka, p. 131, No. 22.

L'ischio-pubo-coccygien. Gervais et Alix, p. 16.

Ischio-pubo-coccygeus. Watson, p. 67.

"B. *M. pubi-coccygeus externus.*

M. pubi-coccygeus. Tiedemann, § 226.

,, ,, ,, Wiedemann, p. 82.

,, ,, ,, Gurlt, p. 19.

M. pubo-coccygeus externus. Gadow, No. 7.

"C. *M. pubi-coccygeus internus.*

M. ischio-coccygeus. Tiedemann, § 227; Gurlt, p. 19.

Depressor coccygis lateralis internus. Wiedemann, p. 82.

M. pubo-coccygeus internus. Gadow, No. 8.

"26. M. pubi-coccygeus externus.

"Dieser Muskel wird nur von der Haut und dem *M. transverso-analis* bedeckt.

would have been found to be a continuation of the last-named muscle.

"Er entspringt bei *Rhea* und *Casuarius* fleischig-sehnig von den ventralen Flächen, der Enden der Querfortsätze der ersten drei Schwanzwirbel und dem distal-caudalen Ende der *Ossa ischii et ilei.* Er geht dann quer über den lateralen Theil des *M. caud. il. flex.* fort, und in einem Bogen zum distalen Rande des *Os pubis,* woselbst seine Fasern sich mit denen des *M. obliquus et tranversus abdominis* vermischen. Bei *Struthio* ist er ganz mit dem *M. pubi-coccyg. internus* vereinigt.

"Die schwach entwickelte Steuerfedern besitzenden *Carinaten* zeigen ein dem bei *Rhea* beschriebenen ähnliches Verhalten. Bei den übrigen *Carinaten* ist der Ursprung (oder Insertion) auf die Ventralfläche der Wurzeln der ausseren 2–4 Steuerfedern beschränkt.

"27. M. PUBI-COCCYGEUS INTERNUS.

"Innerster, eine breite und dünne Schicht bildender Schwanzmuskel auf der Seite des Bauches.

"Er entspringt in allegemeinen von der Ventralfläche der Querfortsätze und der Körper der letzten freien Wirbel und der Endplatte des Schwanzes. Er inserirt sich, fächerförmig ausgedehnt, an der Innen- oder Ventralfläche des distalen Theiles des Scham- und benachbarten Sitzbeines, indem er sich zwischen die distale Grenze des *M. obturator* und des *M. transversus abdominis* schiebt. Nach Aussen wird er vom langen Kopfe des *M. caud. il. fem.* vom *M. pubi-coccyg. externus* und vom *M. transverso-analis* bedeckt, während er nach Innen dem *Peritoneum* aufliegt. . . .

"Bei *Lamellirostres, Megalocephalon, Penelope* ist er an den Wurzeln der 4–5 inneren Steuerfedern befestigt, während nur wenige sehnige Züge zur Schwanzplatte gehen. Bei *Picus viridis* fand ich ihn nur am ventralen Seitenrande der sehr stark entwickelten Endplatte befestigt ; ähnlich bei vielen Singvögeln."

"28. M. ILIO-COCCYGEUS.

M. iléo coccygien. Cuvier, p. 287, No. 4.
Quadratus coccygis. Selenka, p. 101, No. 23.

"Zum System der ventralen Schwanzmuskulatur gehört auch der *M. ilio-coccygeus,* da er wie der *M. pubi-coccygeus* durch Aeste aus dem *Plexus pudendus* innervirt wird, trotz seiner dorsalen Lage.

"Er erscheint nach Wegnahme der Haut auf der dorsalen Seite

In the Raven, it arises, on either side, from a limited area of the ilium just beyond and to the side of the anterior free caudal vertebra. The fibres converge, and end in a tendon which becomes inserted into the tuberosity on the anterior margin of the pygostyle. In passing the neural spines of the other caudal vertebræ, however, it throws off to each one a tendon which is inserted upon their several apices, though somewhat hidden from view by the muscle itself.

It depends upon the muscularity and age of the subject, as to how far forwards this muscle encroaches upon the pelvis for its origin; the older and more muscular the subject, the more extensive the encroachment and area of origin, as a rule. As already stated, this muscle is continuous from back to tail in Reptiles generally.

150. *The levator caudæ* is a long, oblong muscle, considerably larger than the last, and lying immediately to its outer side, and quite intimately connected with it for its entire length by a firm fascia.

It, too, arises from the hinder surface of the post-acetabular area of the pelvis—but not as far forwards as the *levator coccygis*—as well as from the superior

des Schwanzes, seitlich neben dem *M. levator caudæ.* Er entspringt fleischig von der dorso-medialen Fläche des distalen Ilium, und von der Dorsalfläche der Querfortsätze der meisten Schwanzwirbel. Er inserirt sich an der Dorsalfläche der 4–5 äussersten Steuerfedern, welche er spreizt und hebt.

"Bei *Picus viridis* setzt er sich nur an die beiden äussersten Steuerfedern.

"Der *M. ilio-coccygeus* und die *Mm. pubi-coccygei* gehören eigentlich nicht zu den echten (spinalen) Schwanzmuskeln, da sie am Becken inseriren und aus dem *Plexus pudendus* innervirt werden. Sie bilden daher den Uebergang von den Muskeln des Stammes zu denen der Extremitäten-Gürtel."

surfaces of all the vertebræ of the tail, except the pygostyle. It is inserted into the quill-butts of the four rectrices that lie next in order to the pygostyle, which insertion gives it the power of forcibly elevating these four feathers by its contraction.

151. *The transversus perinei*[1] arises, on either side, from the entire posterior margin of the ischium, and from the posterior margin of that portion of the post-pubis which extends beyond it. This somewhat tendinous origin makes a loop at the salient angle where the ischium and ilium unite behind, through which loop the femoro-caudal muscle passes. From this point of attachment a dense fascia extends towards the coccyx, being closely attached to the entire hinder margin of the ilium, and firmly holding down the lower strata of the coccygeal mucles. From this line of origin the fibres composing the thin and sheet-like *transversus perinei* converge and pass towards the median line, to unite in a raphe with the muscle coming from the opposite side, in front of the anus.

These muscles serve to support the viscera here at the lower part of the abdomen, and so, too, perform the function of that muscle found in certain of the Mammalia known as the *levator ani*.

152. *The depressor caudæ* is a strong conical muscle

[1] But few comparative morphologists seem to have designated this muscle by the name I here bestow upon it, although Owen, I believe, used it. Gadow (*loc. cit.*, p. 129), presents us with the following brief synonymy only, viz. :—

"22. M. TRANSVERSO-ANALIS.

M. levator ani ; M. transversus ossium pubis. Gurlt, p. 20.
M. transverso-cloacalis. Gervais et Alix, p. 16.
,, ,, ,, Watson, p. 71.
Aufheber des Afters. Tiedemann, § 430."

which overlies the *depressor coccygis*, and one that is devoted to pulling the tail downwards and outwards, and by an equal contraction of the muscle of the opposite side, directly downwards.

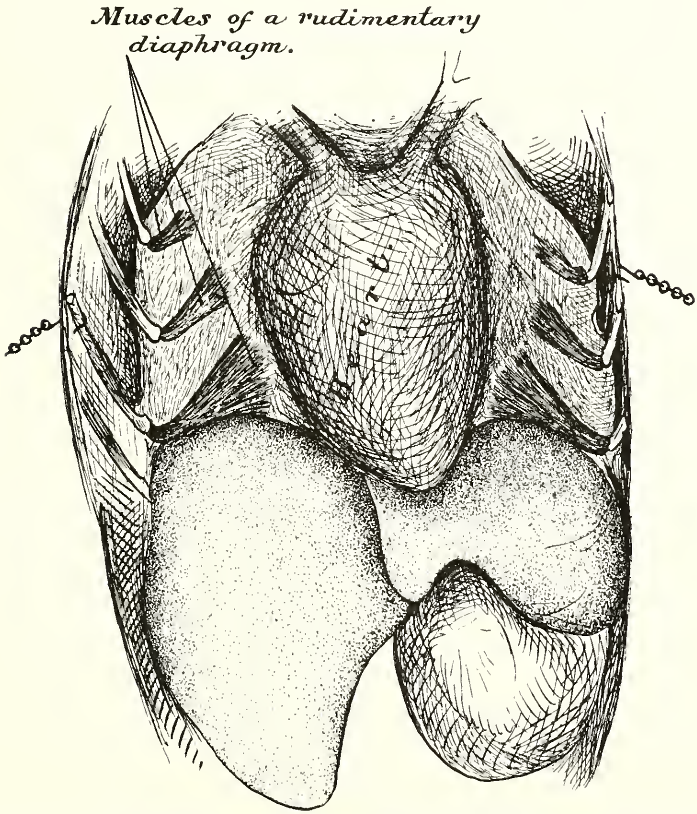

FIG. 75.—An anterior portion of the trunk of a Raven, with the sternum, muscles, and other parts extensively cut away in order to show the rudimentary muscles of the diaphragm. The heart is pushed somewhat forward, and tensely covered by its membranes, &c. The dissecting-chains pull the lateral chest-walls apart. Life-size, by the author, from his own dissections.

It arises from the lower half of the posterior border of the ischium, and from the entire posterior border of

the post-pubis beyond it, all of which is beneath the origin of the *transversus perinei.* The fibres converge as they pass backwards and inwards, and turn in such a way as to permit the muscle to become attached to the quill-butts of the three or four outer rectrices.

This muscle must be cut across, and its extremities reflected, before we can thoroughly examine the next one.

153. *The depressor coccygis* arises from rather more than the lower half of the posterior margin of the ischium, as well as from the anterior three-fourths of the posterior margin of the post-pubic element of the pelvis immediately beyond it. This line of origin lies well within the marginal border of the bones mentioned, as the preceding muscle is more properly attached to their free edges.

Its fibres converge as they pass backwards and inwards, and are inserted, somewhat tendinous, to the thickened rim of the inferior and expanded portion of the pygostyle, on the side corresponding with the origin of the muscle.

154. *The lateralis caudæ* is composed of usually four fasciculi, more or less joined together by their intermuscular fasciæ, the external fasciculus being by far the most distinct one. This arises from the tip of the transverse process of the first free caudal vertebra at the anterior end of the series, and is inserted on the outer side of the proximal extremity of the external rectrix of the tail. The succeeding fasciculi of the *lateralis caudæ* arise, in order, from the tips of the next three transverse processes of the caudal vertebræ following the one just alluded to. Their fibres pass backwards, and are inserted on the under side of the quill-butts of the first two or three outer rectrices.

The combined muscle forms a fleshy mass, at the side of the skeleton of the tail; and it is evident that when the outer fasciculus of the muscle alone contracts, as it may, it will, assisted by an equal force exerted on the part of the corresponding fasciculus of the muscle of the opposite side, tend to powerfully pull the tail feathers apart, and thus spread them. To a certain extent the remaining fasciculi can act in the same way, but they are inserted in such a manner that by their contraction these rectrices will be pulled both downwards and outwards.

155. *The lateralis coccygis* is a powerfully developed muscle found immediately beneath the ends of the transverse processes of the caudal vertebræ, and where it is attached to the expanded part of the pygostyle it blends more or less with the muscle of the opposite side, and the two in this region are firmly braced down by a confining, white and glistening, tendinous fascia, which is at once made conspicuous by the removal of several of the muscles described in the foregoing paragraphs.

The *lateralis coccygis* arises from the nether aspect of the posterior end of the ilium, and by tendons which severally spring from the under side of the ends of the leading three, occasionally four, caudal vertebræ. The combined fibres form a subcompressed muscular mass, directed backwards and slightly inwards, to become attached, on either side, to the posterior margin, exclusive of the midspine, of the expanded portion of the pygostyle beneath.

This pair of muscles control the lateral movements of the tail and the feathers attached to it, and to some extent its oblique downward movements.

156. *The infracoccygis* is that muscle which is

found beneath the skeleton of the tail, and which beyond the fifth caudal vertebra merges to a great extent with the fellow of the opposite side, almost giving it the appearance of an azygos muscle.

It arises, by means of a strong tendinous attachment, on either side, from the inferior surface of the diapophysis of that last vertebra which anchyloses with the pelvic sacrum. It also finds origin from similar positions on the first four free caudal vertebræ; this part of the muscle seems to merge with the one of the opposite side to form a tendinous attachment to the prominent hypapophysis of the fifth caudal vertebra. But notwithstanding this, the same muscle seems to spring again from the under side of the transverse processes of the remaining caudal vertebræ, and here is where the blending seems to take place, not only with the opposite muscle, but as a continuation of the first part described. Finally, this latter fleshy portion becomes inserted into the lower sides of the pygostyle, and by a tendon on its middle infero-spine, or aborted hypapophysis.

This pair of muscles evidently antagonize the levators found on the upper side of the caudal vertebræ and sacrum.

Sir Richard Owen, in his description of the caudal muscles as they were found by him to exist in the Apteryx, bestowed names upon them quite different from those that I propose for them here. In the nomenclature of this anatomist we find such names as the *ischio-coccygeus*, the *quadratus coccygis*, the *pubo-coccygeus*, and others. A careful study on my part of the musculature of this part of the skeleton and its rectricial appendage in the Raven, convinced me that

a far better nomenclature might be adoped for these muscles, as, notwithstanding their various modes of origin and insertion, they were, in this bird at least, evidently arranged upon quite a definite plan.

Of the two pair of *levators* one is devoted to the skeleton and one to the rectrices, and these are directly

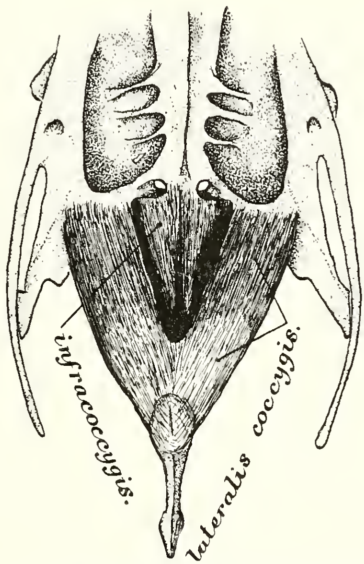

FIG. 76.—Under view of posterior portion of pelvis of a Raven, together with the caudal vertebræ ; designed to show the position of the *infracoccygis* and *lateralis coccygis* muscles. Life-size, and drawn by the author from his dissections.

antagonized by the pair each of which I have called an *infracoccygis*.

Now we still have remaining *lateral* muscles both for the skeleton of the tail and the rectrices, while to these are added *depressors* for the same parts, and omitting the *transversus perinei*, the whole is completed by the *femoro-caudals*, which lead from the pygostyle to a thigh-bone on either side.

A moment's reflection is sufficient to convince us that all those varied movements, so essential to the feathery rudder of this black avian knight, can be executed to a nicety by this wonderfully complete musculature of his caudal extremity.

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Under the words "Synonymy of" have been indexed in alphabetical order the majority of those muscles whose synonyms have been given in footnotes throughout the work.

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THE END.

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